POWER

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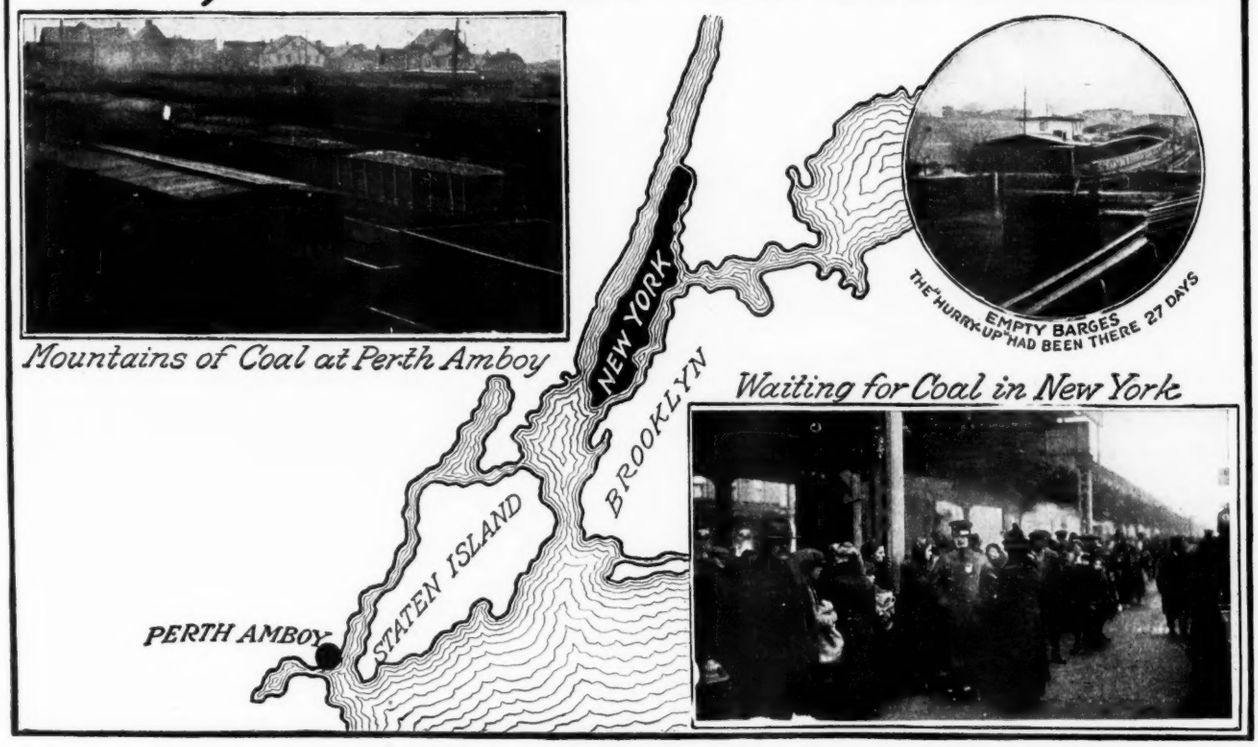
Why New York has no Coal

Mountains of Coal at Perth Amboy



Waiting for Coal in New York

THERE are thousands of tons of coal at the tidewater piers that supply New York City. Yet lines of people a block long wait hours to buy a hundred pounds each at 50 cents. Homes and offices go unheated and pneumonia makes new death records.

For want of barges? No, scores of them wait for days, aye weeks, at each of the piers. Ice? No, the Kill is free now. Labor shortage? No, hundreds of men are available at a fair wage.

Then with the coal, the barges, the men and a free channel, why does the city freeze?

Because the eight piers, operated by the railroads, supplying the city are unloading but 1335 cars per day average, against 1800 last year.

Because the piers are undermanned and the men paid 35 cents an hour, while almost in the shadow of the piers laborers in Government employ get twice as much.

Because the piers are worked 10 hours or so a day instead of 24 hours.

Because the thawing facilities, at one Perth Amboy pier at least, are worked at less than 10 per cent. capacity, while there are not enough facilities at others. Because this pier unloads but three cars at a time instead of a possible 28. Because it employs 26 men instead of a hundred.

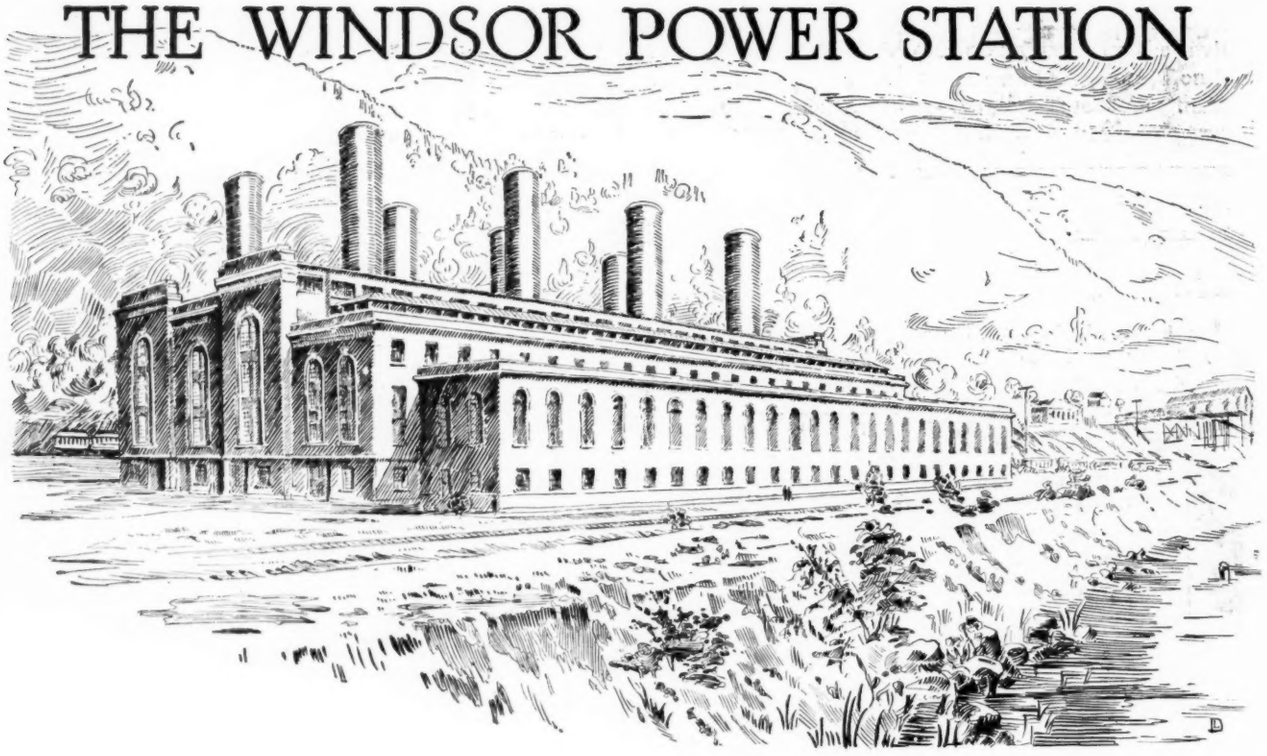
Because a gang of six men spend two days unloading one car of frozen culm.

Because, at this writing, anthracite is not pooled, causing switching and waiting of cars, decrease of coal production and astounding delay of barges.

The miners blame the railroads, who say they are through when they land the coal at tidewater; the pier management blames the shipper for delaying the arrival of his barges. Thus "the buck is passed next door."

(See editorial pages.)

THE WINDSOR POWER STATION



Features in the location, design and equipment of a huge plant located at a coal mine in West Virginia to produce bulk energy for its joint owners, the American Gas and Electric Co. and the West Penn Power Co. Commercial power was first put on the line to Canton, Ohio, Aug. 28, 1917.

WHEN it is looked upon in retrospect, the construction of the $10,000,000 Windsor (W. Va.) plant of the American Gas and Electric Co. and the West Penn Power Co. will probably be seen to mark a new epoch in the central-station industry. Far-seeing engineers and central-station executives now view it as a pioneer station; they see it as one of an interconnected group of great plants strategically located to produce large quantities of energy so cheaply that it may be economically transmitted over wide areas to serve one of the greatest industrial districts in the world. True, plants have been built at coal mines before; but this is a pioneer station in the respect that it is the first coal-burning bulk supply station of any considerable size. Before another year lapses, the station will rank among the world's largest steam plants. It is the initial step toward carrying into actual practice in a broad way what has proved to be successful on a smaller scale in the Middle West with steam and in the Far West with hydro-electric power.

As a bulk supply station the Windsor plant has an enviable situation. Being on the Ohio River, it has an adequate and dependable supply of good water. Fig. 2 is a view of the station at its present state of completion. It is being continued for the second section at the left of the illustration. It is but 2000 ft. from a coal mine that produces fuel running around 13,500 B.t.u. per lb. It is on the Pittsburgh, Wheeling & Kentucky branch of the Pennsylvania R.R. The 58 acres of real estate purchased around the plant site was not expensive. It lies between the Eastern and the Central time belts and receives, therefore, those advantages of diversity which come from serving loads thrown on systems at different times by reason of the arbitrary shifting of clocks as the meridian is passed. Moreover, it lies in what is practically the load center of the eastern Ohio, western Pennsylvania and Wheeling (W. Va.) industrial district which it will serve. This location for a large station possesses the further advantage of serving a territory in which the general run of boiler-feed water gives enough troubles to isolated plants to induce them to central-station service. This water, taken from small streams, is contaminated to a considerable extent by water from the mines. In fact, this exact site was chosen after a thorough search extending on both sides of the Ohio River from Steubenville to Wheeling.

The ultimate rating of the station as it is now laid out will be about 200,000 kw. in six units. Of the first 60,000 kw. of this rating in two machines now in operation, one 30,000-kw. unit was put into commercial service Aug. 28, supplying Canton, Ohio. Two additional units will be completed in 1918. The last two units will probably be installed shortly thereafter. For each turbine there are four boilers, each with 12,625 sq.ft. of heating surface. No. 2 unit of the two now installed is shown in Fig. 1. Each boiler is equipped with a separate economizer and induced-draft fan set over the boiler. Forced draft is also applied under the underfeed stokers. The boilers are arranged on both sides of a wide room, along the center of which is a large concrete coal pit into which fuel is delivered directly from the mine by special transfer cars. From this pit coal is delivered to individual hoppers in front of each boiler.

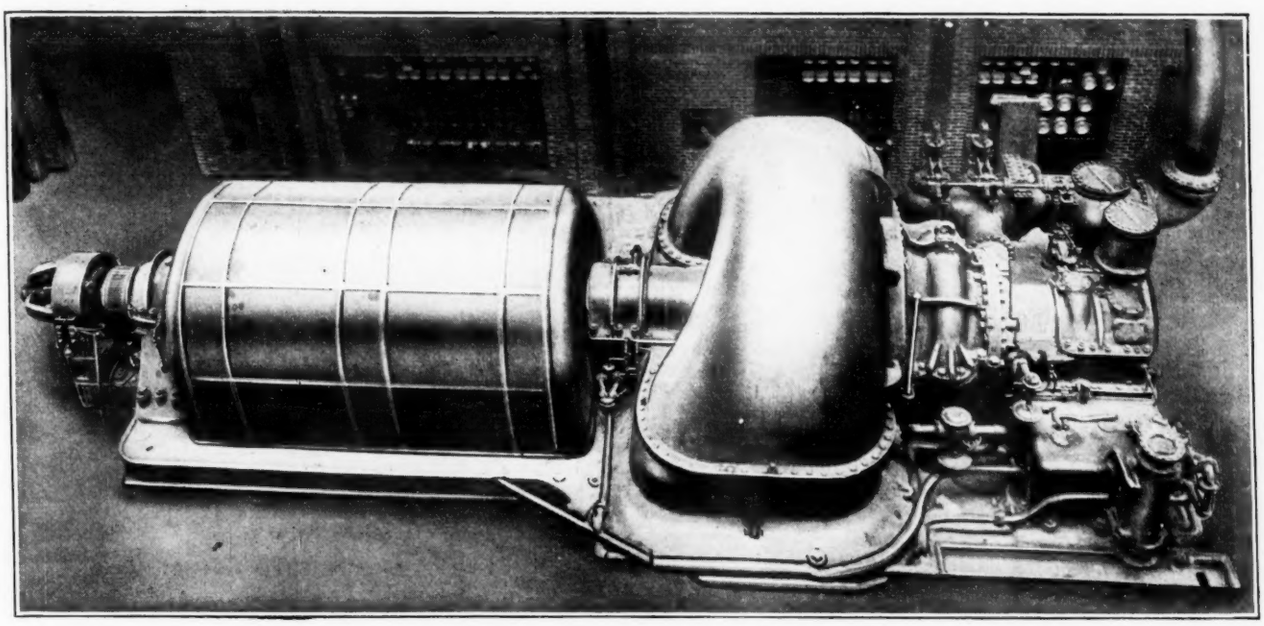


FIG. 1. ONE OF THE 30,000-KW. TURBINE UNITS

In the turbine room the machines are set in a single line with their axes parallel to the firing aisle of the boiler room. The units are grouped in pairs with the steam ends of each pair adjacent to each other and directly over a single condenser pit. This places the operating ends of each pair of units, as well as the condensing equipment of each pair, close together for convenient operation. Between each pair of turbines is a condenser pit 74 ft. deep, the walls of which form the foundation of the turbines (see Fig. 3). This pit contains two horizontal surface condensers each of 50,000 sq.ft. cooling surface, together with the auxiliary condenser motor-driven pump. Details of the condenser design, auxiliaries and intake and discharge arrangement will be published in a following article.

All tracks run into the station on trestles, owing to the elevation by the station above the high-water level of the river. Although these were costly at the outset, the space beneath them will be used for ash dumps for several years to come, providing an economical means of disposing of ashes.

The over-all dimensions of the plant with the six units completed, exclusive of the high-tension yards, will be about 295 x 280 ft. The operating floor is on one floor level, and in a plant of such size this will add greatly to the convenience of operation. Because it is necessary to radiate quantities of heat from the large units, the design has been made especially liberal as regards light and air. The radiated heat from the turbines is conducted from the generators to the basement of the boiler room, where it is taken up by the stoker fans and delivered to the furnaces.

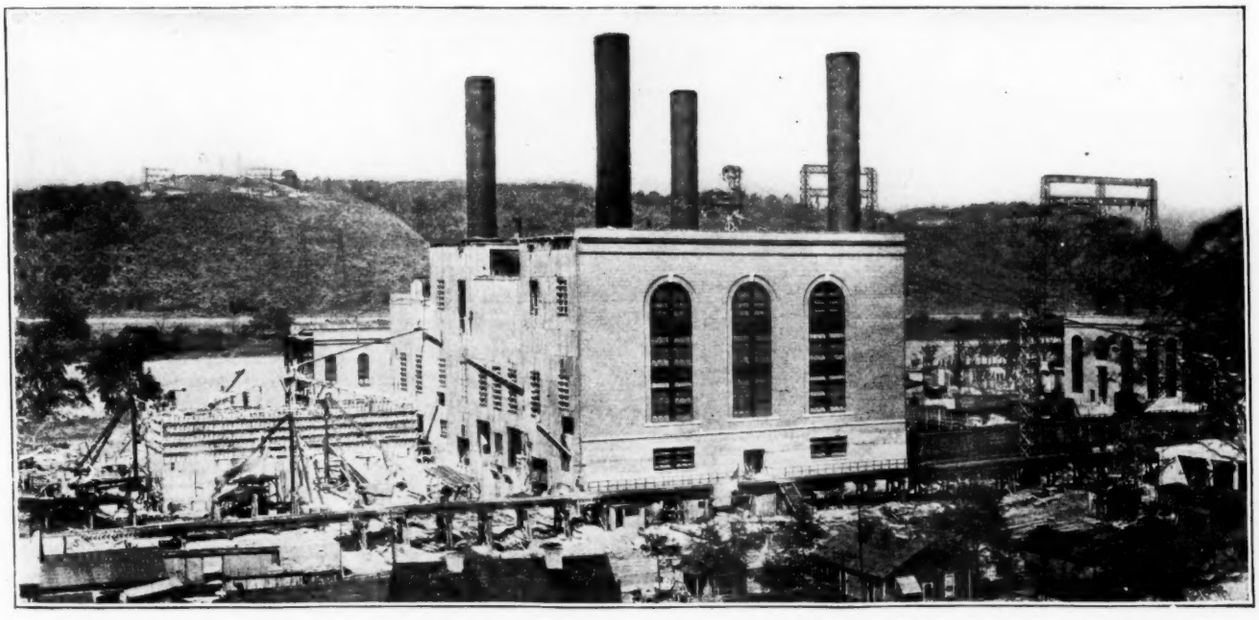


FIG. 2. COMPLETED SECTION OF THE WINDSOR POWER STATION

To get the proper perspective on the electrical end of the plant, it should be viewed in two units; namely, the low-tension or generator-voltage equipment and the high-tension equipment. Control of all low tension and high tension is centered in an operating room, between the original section of the generator room and the switchhouse. The switching of all circuits operating at the generator voltage is accomplished in this switchhouse, which is built parallel to the length of the generator room. The energy is generated at 11,000 volts, and arrangements are made so that ultimately all units in the station can operate at this potential on a ring-bus system with reactors between each two bus units. 52 ft. Still another interesting feature is the utilization of the space over the intake well for the switchboard operating room. This room is supported on 6-ft. steel trusses that span the space between the turbine-room wall and the wall of the switchhouse. The trusses do not interfere with access to the intake well, which the operating force must have for cleaning it at intervals. The 6-ft. space occupied by the trusses has proved of still further value, since it was inclosed and was used as a spacious conduit chamber for all lines leading to the switchboards in the operating room. By dividing the operating room horizontally with a floor, it has also been possible to provide offices for the

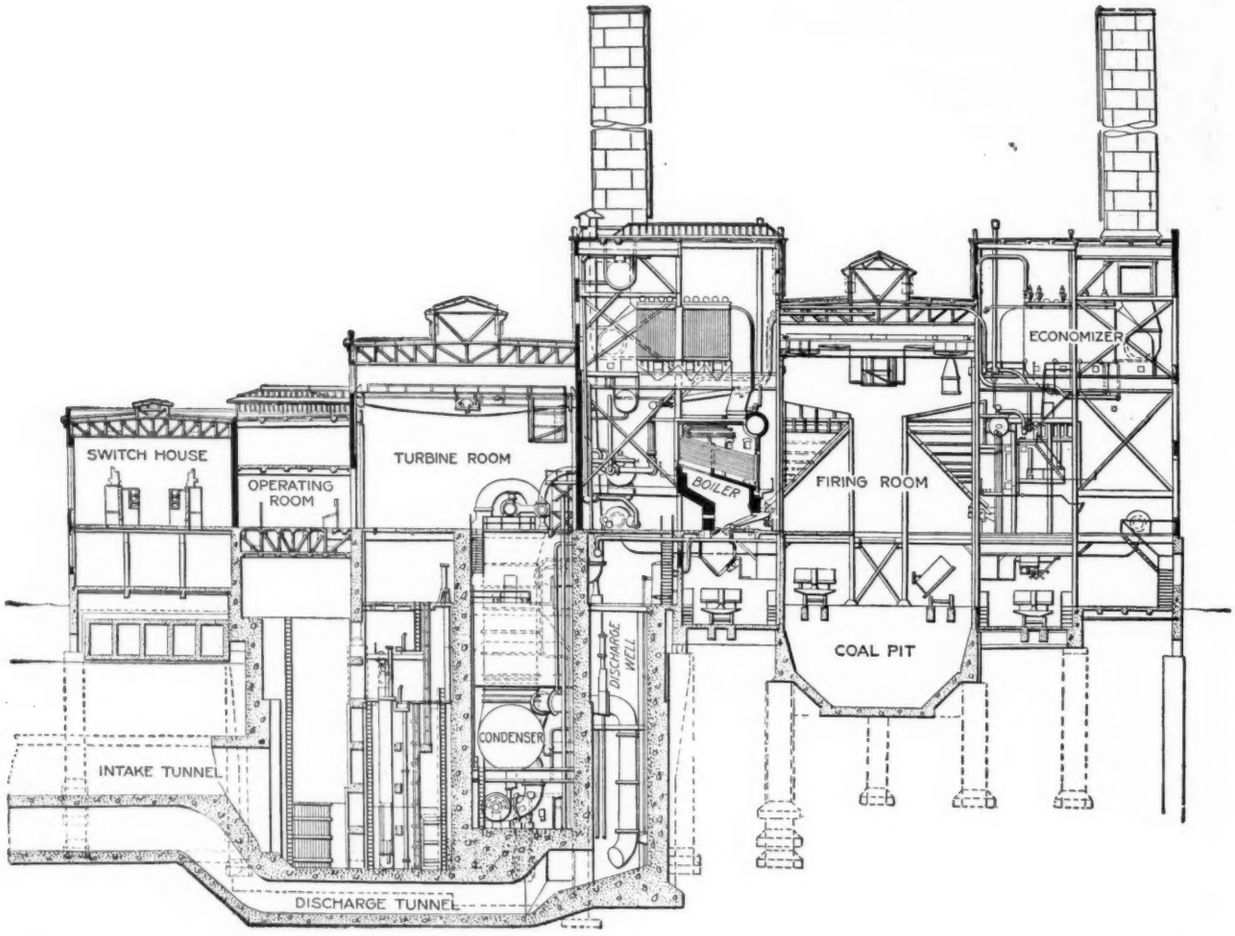


FIG. 3. ELEVATION OF THE WINDSOR PLANT

From the switchhouse the energy is distributed to two separate high-tension yards owned individually by the joint owners of the station. From these yards the electricity is transmitted to distributing companies at four different potentials.

In the building itself are several features of interest. The problem of getting a solid footing under the boiler room and switchhouse was solved by sinking caissons, but the necessity for carrying out this method under the remainder of the station was eliminated by utilizing the walls and foundations of the condenser well and intake crib to support the superstructure. The construction of the boiler-room foundations, generally speaking, consists of seven rows of concrete piers built up from depths below the surface that vary from 28 ft. to

chief engineer and the load dispatcher on the second floor.

The coal-handling facilities at the plant are noteworthy in several respects. Coal is secured under a long-term contract from a mine owned by the Richland Coal Co., approximately 2000 ft. from the power house. It is hauled into the station in side-dump transfer cars on a standard-gage track. All this railroad equipment is owned by the central station. It is considered important that the track is of standard gage, because in an emergency this will permit the shipment of fuel from other mines without inconvenience. At the plant the transfer cars are dumped into a concrete pit which is approximately 35 ft. wide and runs the entire length of the boiler room beneath the firing aisle. From this

pit, which will hold more than 2500 tons of coal, the fuel is lifted in a 3-cu.yd. grab bucket operated from an overhead crane. After being weighed by a device on the crane, it is dropped into the individual hoppers that serve each boiler. This indirect but effective method of handling coal inside the boiler room permits a rather large quantity of fuel to be carried inside the

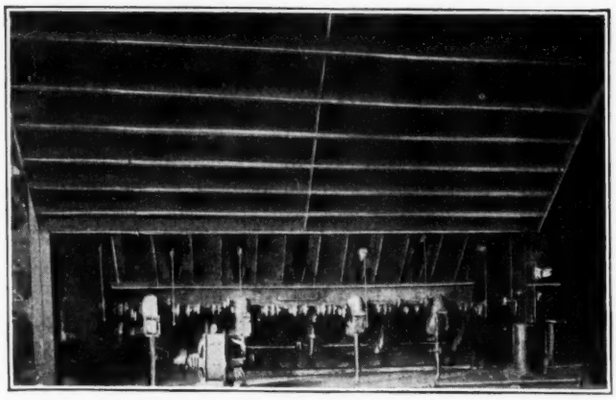


FIG. 4. FRONT VIEW OF ONE OF THE STOKERS AND COAL HOPPERS

plant without great expense, since it was possible to construct the coal pit of concrete instead of steel. A large coal-storage yard will be provided near the plant in the future.

From the hopper the coal goes by gravity to underfeed stokers with fourteen retorts per boiler (Fig. 4). These stokers are each arranged with a blast, a 100-hp. motor-driven fan being provided for each boiler. Stokers of the underfeed type were chosen for this service because they have proved efficient in burning West Virginia coal and have possibilities of high capacities.

The four boilers which serve each turbine are of the water-tube cross-drum type. Each one has 12,625 sq.ft. of heating surface and supplies steam at 250 lb. pressure and 250 deg. superheat. All settings are incased in steel to prevent air leakage. The four boilers which form a unit to serve each turbine are arranged in banks of two facing each other, on opposite sides of the firing aisle. Each bank of boilers is connected to a manifold, which in turn is connected to the steam pipe running to the turbine. Leads from the separate boilers are cross-connected. A feature of the boiler settings is the fact that the center line of the drum is 26.5 ft. above the firing-aisle floor. This arrangement provides an extra-large furnace and insures good combustion of the fuel.

As the gases leave the boiler, they are taken through economizers, Fig. 5. One 8625-sq.ft. economizer is set directly over each boiler. The economizers, which are of the high-pressure type, are arranged in two divisions, 8 tubes wide by 36 tubes long. This arrangement, it is believed, provides for the maximum heat transfer. It also allows the space between the two sections to be utilized for a bypass duct and permits a neat arrangement of the duct to the double-suction induced-draft fan. Moreover, arrangement of the economizer in this manner makes the section narrower and hence more accessible for repairs and cleaning. Dampers are provided in the uptake and are so arranged that in one position they close off the economizer and in the other position the bypass duct. From the economizer the gases pass through a 60-hp. motor-driven fan to a smoke flue which connects three boilers to a 13-ft. by 146-ft. steel stack. The gases are thus actuated by both induced and forced draft and practically a balanced draft condition is maintained over the fire. The stoker-blast equipment is designed to give a pressure equal to 6.5 in. of water. The operation of the induced-draft fans in connection with the forced draft will permit the furnaces to operate almost without pressure in the firebox. Hand regulation is employed to give proper relation of fuel and air. The ash from the furnaces is disposed of by dropping into pits, from which it can be dumped into the same transfer cars that are used for bringing coal to the plant. A plan view of the plant is shown in Fig. 6.

Because the boilers are equipped with economizers and since the large units permit the production of energy at low cost, most of the auxiliaries are motor-driven. In connection with each condensing equipment, there are two hydraulic air pumps driven by 200-hp. motors and two hotwell pumps driven by 100-hp. motors. The hydraulic air pumps are set on the gallery adjacent to the condenser, making a very short suction connection. The hotwell pumps are located on the floor of the condenser well under the condenser. The pumps, which are operated in connection with the condensing equipment, including the 50,000-gal. circulating pumps, are motor-driven.

The condensate, after passing through the condenser, is pumped through a primary heater in the upper part of the condenser up into a feed-water heater of the open type, which is set on a platform immediately over the feed pumps. These pumps and one service pump are the only steam-driven auxiliaries in the plant. There

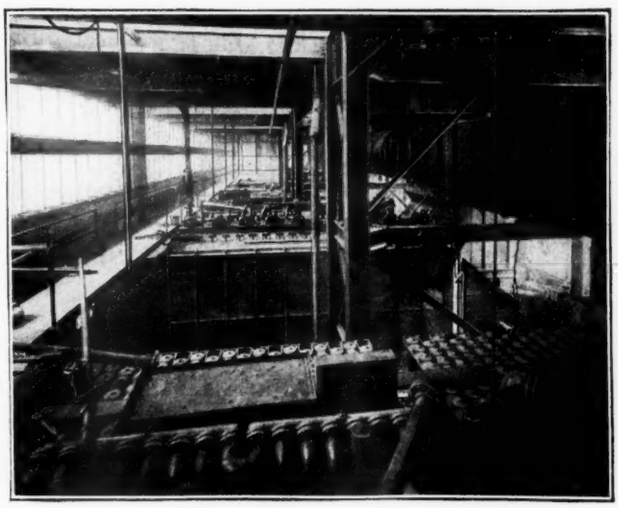


FIG. 5. VIEW ABOVE THE ECONOMIZERS

are two feed pumps on each unit, one of these pumps each on two units being motor-driven and three steam-driven.

Besides those auxiliaries which are attached to each separate unit, there is one motor-driven and one steam-driven turbine service pump located in the condenser well. These units are connected to a steel service tank under the boiler-room roof. This supplies all service and all makeup water, the latter being run through a

settling tank and quartz filter before going to the feed-water heaters. No other water-treating equipment is necessary. From the feed pump water is taken to the boilers through a double-feed system, the main feed being arranged to take water through the economizers and the auxiliary feed being arranged to deliver the water to the boilers direct.

On account of the fact that the condenser well is deep and a large part of the auxiliary machinery is under the condenser, an electric push-button elevator operates between the turbine-room floor and the condenser pit for the convenience of the operators.

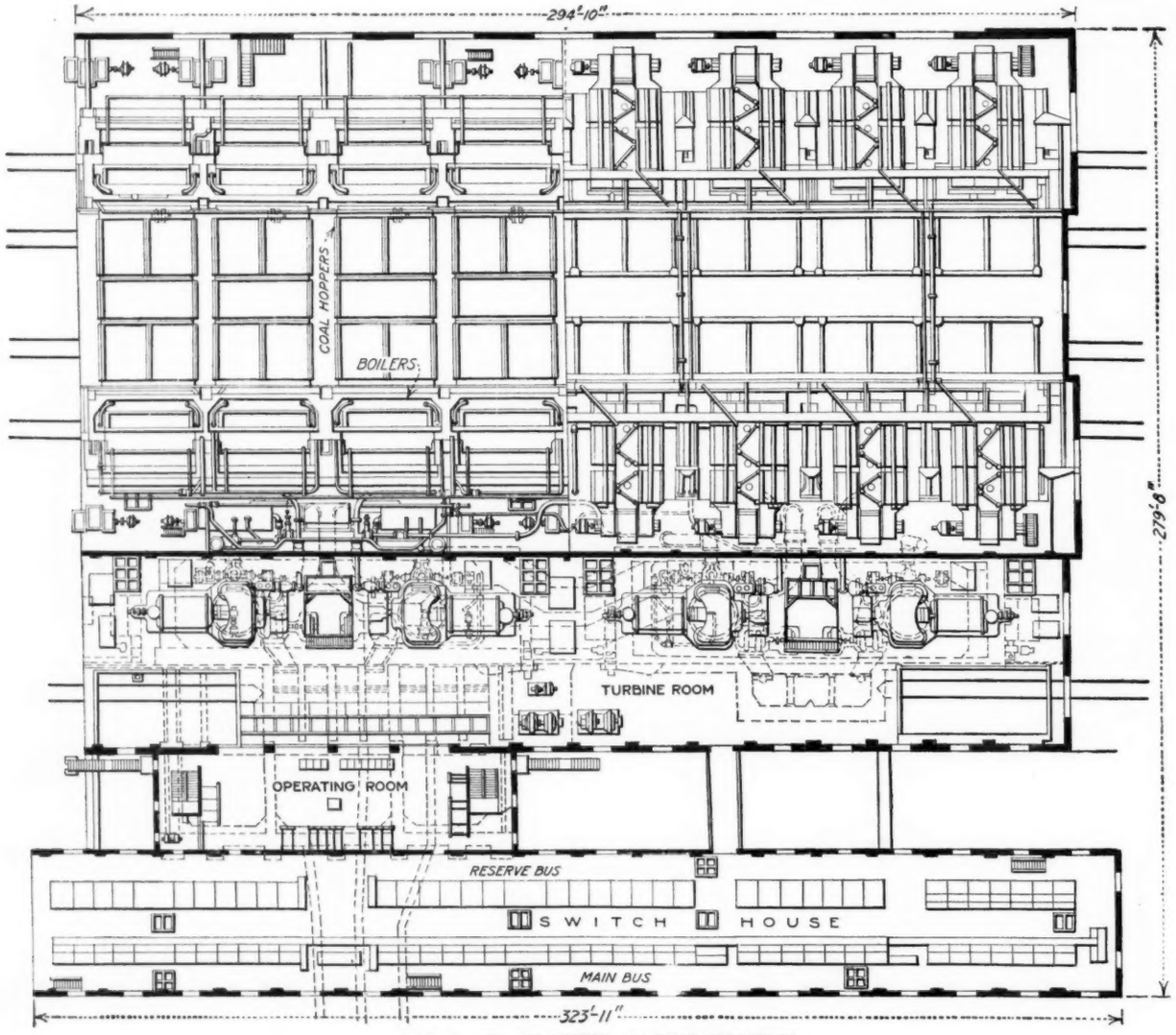


FIG. 6. PLAN VIEW OF THE STATION

In the ultimate layout the six 30,000-kw. 11,000-volt three-phase 60-cycle generators will be arranged for connection to a double-bus system composed of a main bus and a reserve bus parallel to it. The main bus will operate on the ring system, and although the reserve bus will not be operated as a ring at present, space has been left to install the ring connection at a later date if it is thought advisable. For each station unit there is a bus unit so designed as to limit the possible interchange of power between bus sections to an amount well within the guarantee of the oil-switch manufacturers. Between each bus section there is a 5 per cent. reactor, which may be placed in or taken out of the bus by opening or closing a reactor short-circuiting switch. When the generators are paralleled on the bus, they are separated by these current-limiting reactors. In this connection a unique automatic control feature has been worked out. The control circuit for operating the generator switch on the main bus and the reactor short-circuiting switch are electrically interlocked so that when the generator switch is closed, the reactor switch is open and vice versa. This prevents generators being placed on the bus without reactors between them. Provision is made for independent operation of these switches when necessary. Fig. 7 shows a single-line diagram of the main electrical connections of the plant.

The 11,000-volt cables from the turbines are arranged for connection with the 11,000-volt busses in the switchhouse through either of two 2000-amp. oil switches. The busses and switch cell structures are on the turbine-room floor level. The reactors, potential transformers, current transformers, cable terminals, lightning arresters, switch gears and storage batteries which are also in the switchhouse are on the floor below. Beneath this lower floor are cable tunnels which extend out

into the high-tension switchyard, carrying power cables in fiber conduit laid in concrete and control cable in iron conduit on racks.

Each turbine is provided with its own direct-connected exciter, the rating of which is sufficient to carry two generators in an emergency. The rating of each exciter is 210 kw. and the energy required for the maximum field of one machine is 140 kw. Further provision for emergency excitation was made by the installation of a 250-volt exciter bus running the full length of the station. Arrangements are made for connecting all machine exciters and all machine fields to this bus. The bus is also served by a 150-kw. motor-generator set, which was installed with the first two units. Space has also been reserved for an excitation storage battery which will be installed later. There is a voltage regulator on each machine exciter and on the separate motor-driven exciter which supplies the excitation bus.

Each unit is provided with an 1800-kv.-a. three-phase transformer to step down the potential from 1100 to 550 volts to drive the motors of its own auxiliary equipment. The electrical requirements of auxiliaries attached to one unit are about 1500 kv.-a. The stoker motors are not included in this aggregate since they are direct-current machines and are operated from 600-volt motor-generator sets which also supply cranes, hoists, automatic elevators and coal-mining equipment. Two 1800-kv.-a. station auxiliary transformers, in addition to the one attached to each turbine, are operated from the 11,000-volt bus section, and supply motors about the station which are not directly connected with any particular unit. They also supply energy for operating the motor-generator sets which furnish energy for the direct-current auxiliaries.

The feeders leaving the station can be divided roughly into four groups: The 11,000-volt feeders which supply local industries; 25,000-volt feeders which supply a network of the West Penn system; 66,000-volt feeders which supply some of the lines of the American Gas and Electric Co.; 66,000-volt feeders, which will ultimately operate at 130,000 volts and which serve a part of the West Penn system; and 130,000-volt feeders serving the longer lines of the American Gas and Electric Co.

All the feeders leaving the station are laid out on the radial system, arrangements being made for parallel operation of two lines in case of emergency. It is understood by operators, however, that radial operation is preferred and that parallel operation is an emergency measure.

Each of the 11,000-volt feeders is equipped with a 3 per cent. current-limiting reactor. These 3 per cent. reactors, like all other reactors in the plant, were not arbitrarily chosen, but were selected to limit the current that might flow into a short to a value well within the rating of the smallest oil switch in the circuit.

All of the 66,000- and 130,000-volt transformers are wound so as to be interchangeable. Furthermore, the 66,000-volt units are arranged so that they may be operated later at 130,000 volts. To provide further flexibility, arrangements have also been made for connecting together the 66,000-volt busses in the high-tension yards of the two companies.

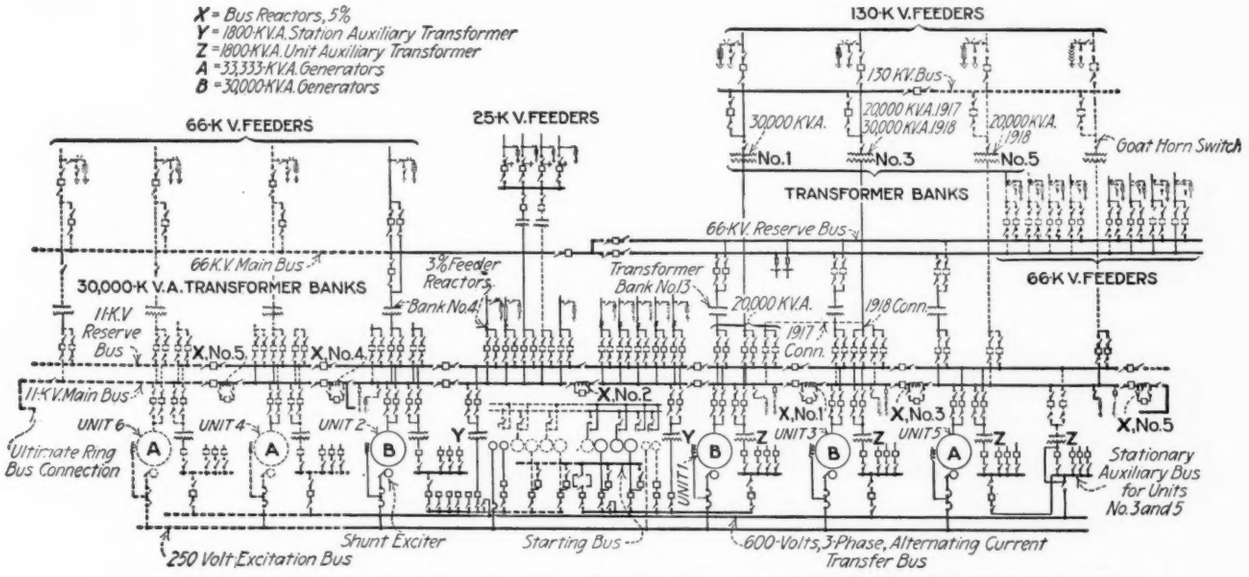


FIG. 7. SINGLE LINE DIAGRAM OF THE MAIN ELECTRICAL CONNECTIONS OF THE WINDSOR PLANT

From the main 11,000-volt bus the energy which is to be transmitted at 130,000 volts leaves the station through 30,000-kw. banks of transformers, the low-tension switches for which are located inside the station, Fig. 9. In the 130,000-volt yard the transformers are tied in solid on the low-tension side. Here a high-tension transfer bus is provided, so that the load from any outgoing 130,000-volt line can be distributed over other operating banks of transformers in case it is necessary to shut down one bank.

In the 66,000-volt yard of the American Gas and Electric Co., a double 66,000-volt bus has been provided; it is at present supplied by a bank of 20,000-kv.-a. transformers, and all outgoing 66,000-volt feeders are connected to this bus. Provision is made for the future installation of a bank of 66,000-volt transformers when the load conditions require it.

In the West Penn high-tension yard the 66,000-volt bus is normally only a transfer bus, the energy being supplied through a bank of 30,000-kv.-a. transformers. The same provision for flexible operation is made in the

yard as obtains on the 130,000-volt bus of the American Gas and Electric Company.

The control of turbines, exciters and auxiliary transformers is centered on a benchboard so located in the operating room that the operator faces the turbine room

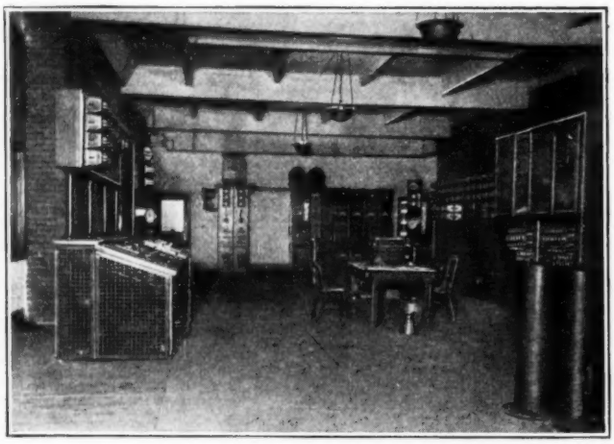


FIG. 8. PARTIAL VIEW OF THE OPERATING ROOM

while handling the equipment, Fig. 8. A glass partition between the operating room and the turbine room permits a view of practically the entire floor of the latter. Outgoing feeders are controlled from a vertical switchboard at the opposite side of the room from the benchboard. Voltage regulators and curve-drawing instruments are located on pedestals at the center of the room. The 600-volt direct-current board and the watt-hour meter board are at opposite ends of the operating room. This arrangement places the switchboards requiring the most attention at the most convenient location for the operator. It was also thought advisable to place the battery-charging equipment and panels in an alcove off the operating room, where they are readily accessible to the switchboard operators. One of the unusual features in this room is a provision for reading the temperatures of transformers in the high-tension yard and the temperatures of important parts of the 30,000-kw. generators. Alarm bells and lamps are also placed here to warn operators of any interruption in the flow of cooling water to the high-tension transformers.

The 11,000-, 25,000-, 66,000- and 130,000-volt feeders are all equipped with induction-type inverse time-limit relays. The transformers are protected by definite time-limit relays. The 25,000- and 66,000-volt relays are given a minimum setting of two seconds. The 130,000-volt relays are set for three seconds. The transformer relays have a minimum setting of three seconds. The 11,000-volt feeders will supply only local territory.

The design and construction of the station, including the high-tension yard of the West Penn Power Co., were carried out by Sargent & Lundy, consulting engineers,

FIG. 9. A BATTERY OF OIL SWITCHES

Chicago. The high-tension yard of the American Gas and Electric Co. was handled by the Electric Bond and Share Co. The subcontracts for the building foundations, the high-tension yard foundations and the railroad foundations were all awarded to the Foundation Company of America. The Riverside Bridge Co. was awarded the contract for the steel.

PRINCIPAL EQUIPMENT OF THE PRESENT WINDSOR, W. VA., POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Turbines	Steam, horizontal	30,000-kw., 80 per cent. power factor	Main generators	11,000-volt, 3-phase, 60-cycle, 1,800 r.p.m., 230 lb. steam, 200 deg. superheat	General Electric Co.
8	Boilers	B. & W. water-tube	12,625 sq.ft. heating surface	Main steam generators	250 lb. pressure, 250 deg. superheat	Babcock & Wilcox Co.
8	Cleaners	Soot		Boiler tubes	With steam pressure	Diamond Power Specialty Co.
8	Stokers	Front inclined underfeed	14-retort	Boiler furnaces	Motor-driven, silent-chain drive	Westinghouse Elec. & Mfg. Co.
8	Motors	Direct-current	35-kw	Driving stokers	600-volt d.c., variable-speed	Westinghouse Elec. & Mfg. Co.
8	Economizers	High-pressure	8,256 sq.ft. heating-surface	One with each boiler	Placed above the boilers	B. F. Sturtevant Co.
8	Fans	Multivane, double-suction		Induced draft	290 r.p.m., placed above boilers	B. F. Sturtevant Co.
8	Motors	Induction	60-hp	Driving induced-draft fans	290 r.p.m., 500 volts, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
8	Fans	Conodial, double-suction	3,500 lb. air per min.	Forced draft	Placed back of boilers, motor-driven	Buffalo Forge Co.
8	Motors	Induction	100-hp	Driving forced-draft fans	500 volts, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
4	Stacks	Steel, brick-lined	150 ft. high, 13½ ft. dia	Three boilers per stack	With forced and induced draft	
2	Condensers	Leblanc, surface	50,000 sq.ft	With main turbines	29.2 in. vacuum expected with 75-deg. water	Westinghouse Electric & Mfg. Co.
2	Pumps	Double-runner	50,000 gal. per min	Circulating water to condensers	350 r.p.m., motor-driven	Worthington Pump & Machinery Co.
2	Motors	Induction	600-hp	Driving circulating pump	350 r.p.m., 550-volt, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
2	Heaters	Open		Feed-water heating	Takes water from primary heater	Warren-Webster & Co.
4	Pumps	Turbine	6-in	Boiler feed	One motor, three turbine-driven	Worthington Pump & Machinery Co.
1	Motor	Induction	300-hp	Drives 6-in. boiler-feed pump	1,750 r.p.m., 500-volt, 3-phase, 60-cycle	Westinghouse Elec. & Mfg. Co.
3	Turbines	Horizontal	300-hp	Drives 6-in. boiler feed pumps	Direct-connected	Westinghouse Elec. & Mfg. Co.
2	Pumps	Turbine		Station service and makeup water	One motor, one turbine-driven	Worthington Pump & Machinery Co.
	Screens	Revolving		Condenser intake	Continuously	Chain Belt Co.
	Cranes, traveling, for turbine and boiler rooms					Whiting Foundry and Machinery Co.
	Oiling system					Richardson-Phenix Co.
	Equipment for American Gas & Electric Co.'s high-tension yard					General Electric Co.
	Equipment for West Penn. Power Co.'s high tension yard					Westinghouse Elec. & Mfg. Co.

Effect of the War on Engineering Education

By C. R. MANN

The engineer, not the banker, the real power behind the throne. He is vitally involved in the control of credit, in the interpretation of the daily news and in the organization of industry and commerce. There must be closer coöperation between school and industry. The war has revealed a profounder appraisement of human values and costs and has hastened the transformation of the individualistic man into a community man willing to do his best for the common welfare. The day of the real industrial university is at hand.

THREE years ago most of us thought that a world war could not last long because, however much kings and kaisers might wish to continue, the banker would stop it. But the financiers have not come up to our expectations in this matter, and we have therefore been compelled, unwillingly perhaps, to recognize that money is not the ultimate measure of national strength. National credit is the result and not the cause of intelligent industrial production; the engineer, not the banker, is the real power behind the throne.

This fundamental fact now seems so simple and self-evident that it is rather hard to remember the time when we thought otherwise. But though the rugged outlines of this fact are now sharply silhouetted against the ruddy dawn of the new age, the details of its meaning are but dimly discernible through the haze of speculation over the significance of the struggle. Naturally, the engineer is intensely interested in the development of the details of the picture, for on him devolves th duty of interpreting the coming conceptions in terms of materials and organizations of men. And if education makes men, engineering education must be the first t feel the thrill of the dawning day.

Three Elements Can Be Perceived

Three elements in the picture can now be plainly perceived. These indicate that the engineer is from hence forth vitally involved in the control of credit, in the interpretation of the daily news, and in the organization of industry and commerce to make goods cheap and men dear.

In performing the first of these new functions the engineer becomes the partner of the banker to determine which projects are worthy of financial support and which not. As the engineering spirit is more and more infused into this dispensing of credit, public service rather than excess profit becomes the inspiration for enterprise; intelligence in production becomes the best security for loans; ability to deliver the goods becomes the sure basis of financial success; and the control of tools gradually passes from the hands of those who own them legally into the hands of those who can use them effectively.

Newspapers and periodicals already sense the expansion of the engineering spirit in the struggle to make the nation strong. The distribution of wheat, the supply of sugar, the transportation of coal and the price of bread are now subjects that occupy an amount of space in the daily press that only a Thaw trial could formerly command. The public has never before realized how vital and how interesting factories, freight cars, warehouses, terminals, trucks and ships really are. Some faint conception of the necessity of organization for the common project of liberating life by winning the war seems to be taking shape; while an impelling desire to serve and to subordinate personal preferences to community interests appears to be dimly developing. These faint feelings of fraternity may grow into driving impulses if editors continue to extol engineering enterprise rather than private profit in their interpretations of the daily news.

Engineers Have Organized To Build Up Business

In many communities chambers of commerce or groups of engineers have organized to build up business and boom the town. Through their efforts living conditions have been improved and many a city is being made a better place for homes. But the progress has always been hampered by the vested rights of individuals and of corporations, so that none has yet dared to envisage an entire community as a single working plant for the purpose of organizing it for the most intelligent production of human wealth. This can now be done. The war is opening many hitherto blind eyes to see that each gains more than he loses when he merges his strength with the might of all in an organization that is constructed for the purpose of releasing creative energy by giving each the work he is best qualified to do.

The time has come for such an organization in every community and every state, because the Federal Government is struggling to shape the nation into an organization of this type. Only so may the nation be strong; only so many communities add their utmost to the nation's strength. The responsibility for this work must finally be shouldered by engineers who are both masters of the mechanic arts and molders of men.

For many years this country has been drifting toward the realization of these requirements. The war has but accelerated the process and precipitated conclusions that were bound to come, otherwise men trained by experience to meet the present crisis could not now be found. Continuity demands that the same conclusions remain valid long after the war is ended. Therefore, engineering schools will render service in proportion as they grasp the implications of these conclusions and express them effectively in the daily work of instruction.

Closer Coöperation Between School and Industry

The possible conclusions for engineering education are many and complex, but two stand out in bold relief; namely, there must be closer coöperation between school and industry, and there must be more attention to the appraisement of values and costs.

The essential feature of the coöperation with industry is not the skill, the knowledge of workmen, or the feel of the machines which the student acquires from shop experience. Important as these are, they cannot compete with the spirt of investigation which must develop

if the coöperation between school and industry is real and vital. There are thousands of unsolved problems in even such rough shopwork as freshmen are permitted to do. The boy should be trained to discover these unsolved problems and to bring them back to school for discussion and solution. By making shopwork in industrial plants the source of problems for solution in school, and by relating the class and the laboratory work in some degree to the problems raised, conditions most favorable to the self-development of the student may be realized. As he progresses, the problems become more and more intricate; until in his last year, if he has shown real engineering ability, he may be assigned as helper in industrial research, either at the plant or in the school laboratories. After such a training in defining and solving problems, closely coördinated with instruction in science and drill in mathematics, he should be able on graduation to take a responsible position without serving several years as an apprentice as is usual under present conditions.

To the faculty this type of coöperation with industry brings incentives for creative work in production and in education. For coöperation makes the school the source of solutions of industrial problems, not only with respect to the technique of manufacture, but also concerning the correlation of the community's productive processes with the training of its citizens as intelligent workers. Hitherto manufacturing companies have stood aloof and regarded one another with suspicion—and the Federal Trade Commission discovered that 200,000 of them are not paying expenses; but now they are ready to coöperate. Similarly in education, many manufacturers are supporting corporation schools to train their own help, while more than half the children in the entire country quit school at the sixth grade without being trained to earn a living; but they too are now ready to coöperate. If the men who are teaching in engineering schools rise to the responsibility and organize for the systematic study of community production, they could soon create a true university, with its feet firmly planted in industry and its soul consecrated to the task of utilizing science and literature to liberate the creative energies of men.

Appraisement of Values and Costs

While close coöperation between school and industry gives that practical experience which is essential for mastery of the mechanic arts, it is not in itself sufficient to enable the schools to meet adequately the fundamental requirements of engineering in the new epoch. The Germans are technically well trained in the mechanic arts, yet they are but brutally strong. In order to strengthen the nation by infusing the engineering spirit in the control of credit, in the interpretation of the daily news and in the organization of industry for the production of human wealth, the engineer must have sound judgment in the appraisement of values and costs. This requires not only an understanding of finance and the meaning of money, but also a sympathetic appreciation of the things humanity holds to be most worth while. Even a practical project like building a bridge is ultimately controlled by some man's decision that the resulting value is worth the cost; and this decision is more difficult and subtle when it concerns profoundly the production of human wealth and the appraisement of human values and costs. The engineer is too often obliged to be only the employee of the bank, the corporation or the state commission, because he believed that engineering is wholly a matter of technical skill; when control in this, as in everything else, is really vested in the decision of the question whether the game is worth the candle.

The training in the appraisement of values and costs does not require the addition of formal courses for that purpose, but rather the injection of this point of view into every branch of school work. For example, experiments in chemistry need not always be of the type, "Analyze this baking powder." The project, "Make baking powder and find out if it is cheaper and better than any you can buy," is vastly more effective as a training exercise. Presented as a personal effort to appraise the human values and costs in life's experiences, literature fascinates engineering students. Economics delights them when it is a critique of proposed solutions of the social problems defined by their daily coöperation with labor. Such exercises also foster the development of those homely virtues which always make the working people the bulwark of a nation's strength—the sense of justice, feelings of neighborly kindliness, devotion to right and respect for God and man.

Opportunity of the Industrial University

Thus because the war has revealed a profounder appraisement of human values and costs, and because the war has hastened the transformation of the individualistic man, selfishly seeking his own personal profit, into a community man willing to do his best for the common welfare, the ideal that was set for the engineering schools in the passage of the Morrill Act in 1862 may now be achieved. For many of the first schools founded under that act were called "Industrial Universities"; but they soon dropped the "industrial" from their titles, fearing lest they lose caste in academic councils. But now, if they gladly grasp the opportunity opening before them, they will claim with pride their abandoned surname and proceed to demonstrate that the engineer, the creator of a new earth, is also the prophet of a profounder philosophy of life.

Carbon-Monoxide Gas Poisoning

Breathing of furnace gas, smoke in burning buildings, the "afterdamp" of explosions of coal dust, etc., has caused many deaths due to poisoning by carbon monoxide. How this kills is described in the Journal of the American Medical Association.

Carbon monoxide has an avidity for hemoglobin, the red coloring matter of the blood, with which it forms the same combination as does oxygen, only 250 times as powerful.

It is, however, a misapprehension to suppose that this combination is permanent. A man brought out to the fresh air, or, better still, to whom air mixed with oxygen can be administered, will generally recover if exposure is within the following limits.

As a rough estimate, it may be stated that usually a man will die who has breathed 0.2 per cent. of carbon monoxide mixed with air which is in other respects normal, for four or five hours, or 0.4 per cent. for one hour. With from 2 to 5 per cent. of carbon monoxide death follows almost as quickly as in drowning.

The Electrical Study Course—Commutator Construction

The construction, methods of insulating and different materials used for insulating commutators for direct-current machines are described.

IN A previous lesson it was shown that if a single coil is connected to rings R_1 and R_2, as in Fig. 1, and revolves between the poles of a magnet as indicated, an alternating current would be caused to flow in the external circuit C. It was also shown that this alternating current could be changed into a current that flows in one direction—that is, a direct current—by connecting the ends of the coil to a divided ring S_1 and S_2, as in Fig. 2. This divided ring represents the simplest form of what is called a commutator on a direct-current machine. Fig. 2 also represents the simplest form of an armature, one that has only one coil revolving in a two-pole field. In the commercial type of direct-current generators a large number of coils, depending upon the size of the machine, are arranged on the armature and connected to a commutator.

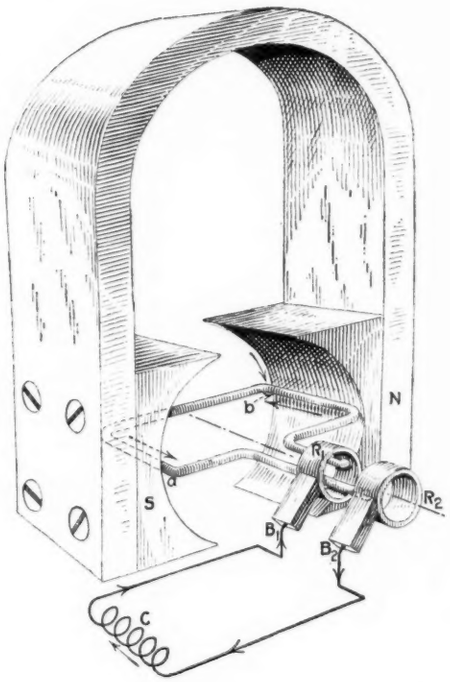


FIG. 1. ONE-COIL ALTERNATING-CURRENT GENERATOR

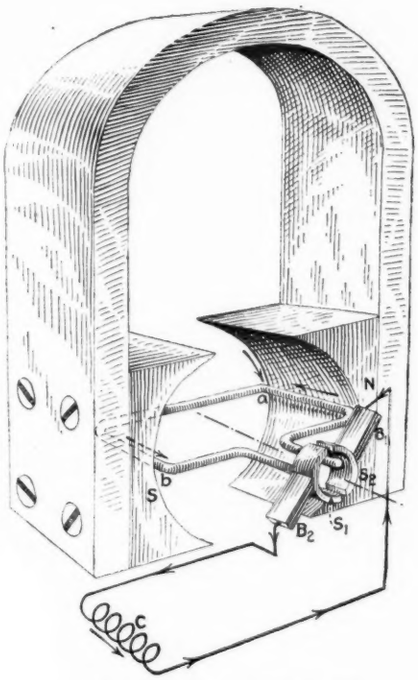
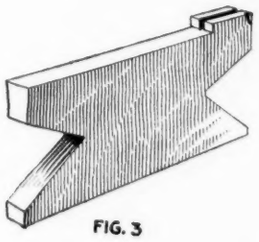
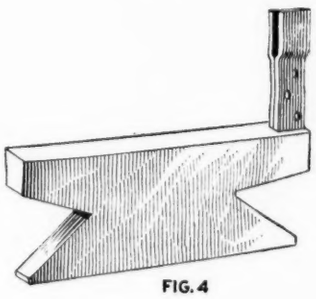


FIG. 2. ONE-COIL DIRECT-CURRENT GENERATOR





FIGS. 3 AND 4. TYPES OF COMMUTATOR BARS

The commutator is made up of a number of copper segments similar to the one in Fig. 3, each segment being insulated from the other. These segments are slotted in one end, as shown, so that the armature-coil leads may be easily connected. Many of the large-sized commutators have an extension soldered to each segment or bar, as in Fig. 4, so that, instead of the coil leads being bent down to the commutator, they are brought out almost on a level with the periphery of the armature.

Fig. 5 shows a section through a common type of commutator. The black lines A across the surface are insulation, usually mica, between the segments. The heavy black lines B are also insulation, therefore it is evident that each segment is insulated from the iron or steel form. Each division on the commutator is called a bar or segment. The bars and insulation are assembled on the vee and sleeve C. Then the front vee, D, and its insulation are put in place and the nut E, which is threaded on the sleeve C, is screwed up as tight as it can be drawn. On account of the expansion and contraction of the commutator, caused by wide variations of temperature and strains due to centrifugal force, it is necessary that the clamping rings hold the bars and insulation very tight, or there will be a movement of the bars that will cause serious trouble.

The insulation used between the bars is usually mica or micanite, about $\frac{1}{32}$ in. in thickness, and in fact this is the only material that has been found that will stand up under all conditions. Micanite consists of thin flakes of mica built up into sheets and held together by a suitable binder. In some of the small-sized commutators, during the last two or three years, the bars are molded into the metal sleeve with an insulating compound. This construction for small-sized machines seems to give satisfactory results. In the early development of the art various material were tried for insulating commutators, such as red fiber, fish paper, asbestos, etc., and various combinations of these materials and also mica and other insulations built up in alternate layers, but all have been discarded.

One of the troubles with most of the substitutes for mica insulation in commutators is, they are easily eaten away in case of sparking at the brushes. Furthermore, all fibers or papers are subjected to more or less contraction and expansion due to moisture conditions. This eventually led to slight looseness between the bars and insulation, so that oil or copper and carbon dust could penetrate and cause pitting of the commutators. One of the chief requisites of a commutator insulation is that it shall not be affected by moisture and changes of temperature; also, it must possess a certain elasticity so that it will fill the space between the bars irrespective of the expansion and contraction of the commutator. So far, mica seems to possess these requirements to a greater extent than anything else. The story of cummutator insulation is one of the most interesting chapters in the history of electrical development.

Many other kinds of commutator construction are used, especially in the older types of machines, besides that shown in Fig. 5, some of which are indicated in Figs. 6 and 7, from which it is seen that the general principle is the same. In the larger-sized machines the commutators are built upon a cast-iron spider, the same as the armature core. Fig. 8 shows a cross-section of a large commutator that is representative of large-sized construction.

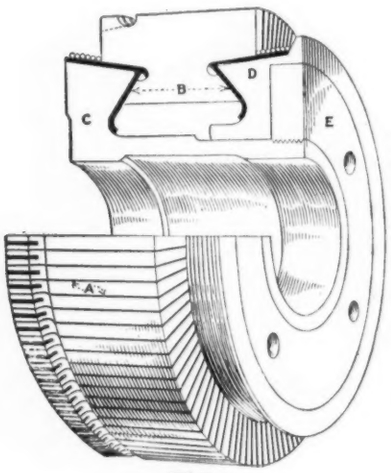


FIG. 5

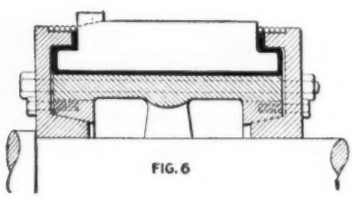


FIG. 6

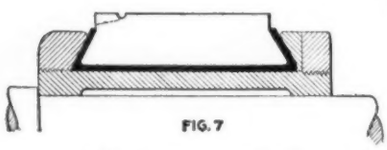


FIG. 7

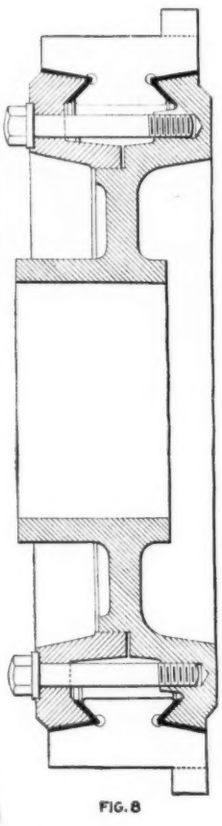


FIG. 8

FIGS. 5 TO 8. TYPES OF COMMUTATORS

In problem 1 given in the last lesson, the cross-section of the conductor was 18,750 cir.mils. The resistance per foot of copper is $R = \frac{10.7}{\text{cir.mils}} = \frac{10.7}{18,750} = 0.00057$ ohm. When 35 amperes is flowing through the conductor, the volts drop per foot is $E_d = RI = 0.00057 \times 35 = 0.01995$ volt.

Fig. 9 is a layout of problem 2 given in the last lesson. If the cross-sectional area of the line conductors is 6530 cir.mils, or No. 12 B. & S., then their resistance is that

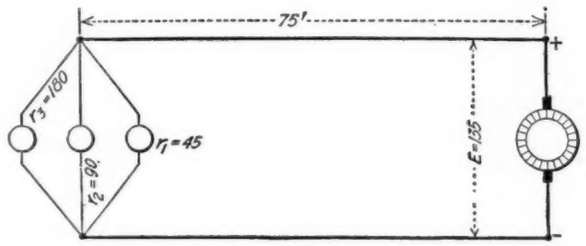


FIG. 9

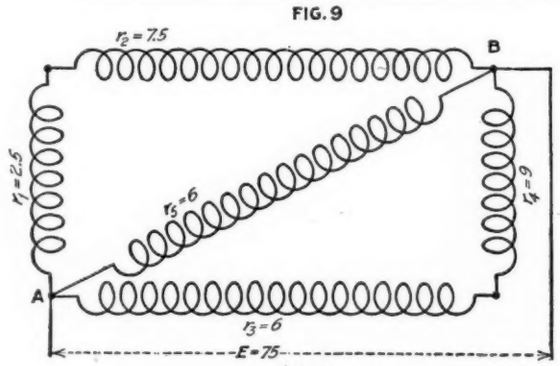


FIG. 10

FIGS. 9 AND 10. COMPLEX CIRCUITS

of 150 feet of No. 12 wire, from which $R_1 = 150 \times 0.0016 = 0.24$ ohm. The resistance is also $R_1 = \frac{10.7L}{\text{cir.mils}} = \frac{10.7 \times 150}{6530} = 0.24$ ohm.

The joint resistance of the three lamps in parallel is

$$R_2 = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \frac{1}{\frac{1}{45} + \frac{1}{90} + \frac{1}{180}} = \frac{1}{\frac{7}{180}} = \frac{180}{7} = 25.7 \text{ ohms}$$

Then the total resistance of the circuit is $R = R_1 + R_2 = 0.24 + 25.7 = 25.94$ ohms, and $I = \frac{E}{R} = \frac{135}{25.94} = 5.2$ amperes.

The value of the current in the circuits will be inversely proportional to their respective resistances; that is, since r_3 has the highest resistance of the three lamps, the value of the current in this circuit will be the lowest. Since r_2 is one-half the value of r_3, if one part of the current flows through r_3, two parts will flow through r_2, and as r_1 has only one-quarter the resistance of r_3, if one part of the current flows through r_3, four parts will flow through r_1. From this we can say that the current may be divided up into seven parts, one part flowing through r_3, two parts through r_2 and four parts through r_1. If seven parts equal 5.2 amperes, one part equals $\frac{5.2}{7} = 0.743$ ampere, two parts equal $0.743 \times 2 = 1.486$ amperes and four parts $= 0.743 \times 4 = 2.972$ amperes; that is, r_3 takes 0.743 ampere, r_2 1.486 amperes and r_1 2.972 amperes.

Another way of finding the current in the three circuits is to find the value of the volts E_a at the lamp terminals, and then by Ohm's law find the current in each circuit. The volts drop in the line is $E_d = R_1 I = 0.24$

$\times 5.2 = 1.248$ volts, and $E_a = E - E_d = 135 - 1.248 = 133.752$ volts. Then the current in r_3 is $i_3 = \frac{E_a}{r_3} = \frac{133.752}{180} = 0.743$ ampere; in r_2 is $i_2 = \frac{E_1}{r_2} = \frac{133.752}{90} = 1.486$ amperes; and in r_1 is $i_1 = \frac{E_1}{r_1} = \frac{133.752}{45} = 2.972$ amperes, which checks up with the values obtained by the foregoing methods.

1. In Fig. 10, find the joint resistance between points A and B. If points A and B are connected to a 75-volt circuit as shown, what will be the total current flowing in the circuit and the current in each branch?

2. At 115 volts a given circuit takes 15 hp. Find the current flowing in the circuit and the ohmic resistance.

Garabed: Boon or Buncombe?

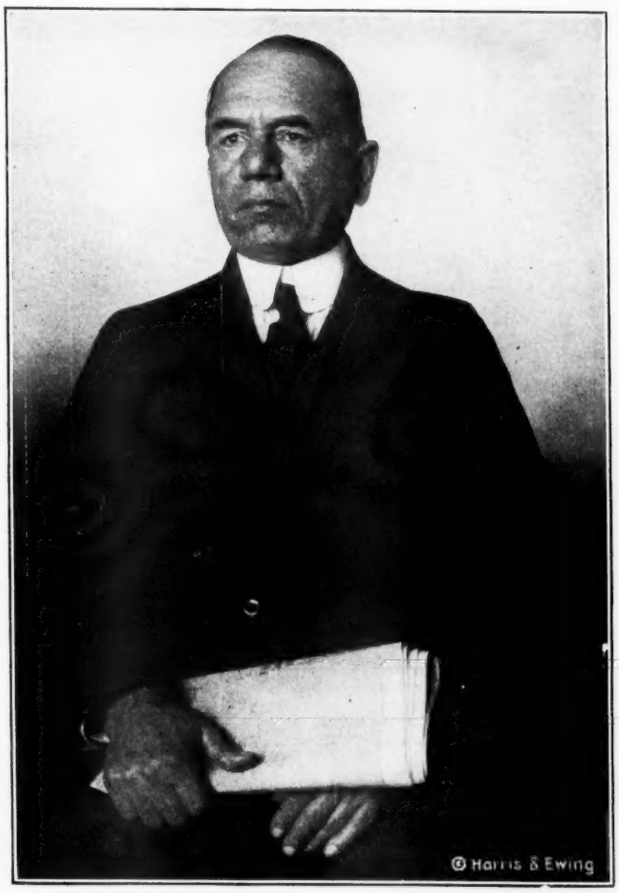
Jules Verne in all his vivid imaginings never conjured up a more astounding and unbelievable story than that which is being told by Garabed T. K. Giragossian, a naturalized Armenian, who claims to have discovered a supply of free energy and to have invented and perfected a means whereby that energy can be converted into usable forms. He denies emphatically that it is perpetual motion or that it in any way controverts the law of conservation of energy, over which so many would-be inventors have tripped. He simply makes use of an inexhaustible quantity of energy that exists everywhere and that cannot be monopolized.

No one except the inventor has any information as to the exact nature of the free energy or the method by which it is used. He has firmly and consistently declined to divulge the secret until both the idea and the machinery for its development have been fully protected. This has been accomplished by the passage, on Jan. 16, of a joint resolution by Congress, authorizing the acceptance of the invention for the free use of the United States Government, protecting the inventor for a period of seventeen years, and providing for the appointment of five eminent scientists (to be approved by the Secretary of the Interior) to determine whether the discovery is a splendid benefaction or a stupendous bluff.

Mr. Giragossian, who is a citizen of Boston, has named his discovery the Garabed. With it he proposes to displace the steam engine as a prime mover. The steam boiler will be relegated to the scrap heap or the museum of antiquities. Smoke troubles will be at an end, for coal will be no longer needed for fuel. Petroleum will be used largely for making soap. The industries of the earth, the needs of the home, the illumination of cities, all the innumerable activities of humankind will eventually depend on the Garabed.

So far as it is possible to conjecture, the atmosphere is the inexhaustible reservoir of energy to which Mr. Giragossian refers, for, at a hearing before the House Committee on Patents, he was asked whether his process or contrivance is applicable to the submarine, and he declined to give an unequivocal answer. He does claim, however, that the motor by which he utilizes the free energy can be used for ship propulsion, haulage of railway trains, driving airplanes, production of electricity, pumping water, and doing the thousand-and-one things that have hitherto been done by steam engines and other types of motors; and he claims further that his motor will operate with the same certainty and regularity in all climates and at all altitudes, without human assistance.

The advantages of such a device—if it actually exists outside the imagination of Mr. Giragossian—are obvious. It is absolutely independent of auxiliary apparatus, for it is complete in itself, whereas the steam engine must have a boiler with its furnace, pump and other accessories. The Garabed is much smaller and lighter than the steam engine of equal output, is easily portable and will produce power anywhere at no cost other than the wear and tear on the machinery. With practically unlimited power at little or no expense, human labor will be vastly lightened and labor troubles will disappear. At the same time the productive capacity of industry will be enormously increased, and the present era of prosperity will be insignificant in comparison with that which will come when the Garabed is used universally.



GARABED T. K. GIRAGOSSIAN

The effect on social and economic conditions will be equally startling and revolutionary. Free energy in unlimited amounts will result in the production of an abundance of all those things necessary to the existence and comfort of the race. Thus, poverty will be wiped out and luxuries made the heritage of all.

Such prophecies as these have been made before and have been met by the sneers and laughter of all classes of people. Mr. Giragossian has not been exempt from

ridicule; but his unwavering faith in himself and in the incalculable value of his discovery has made him indifferent to the derision of his fellowmen. For twenty years he has patiently pursued the task of developing his idea and rendering it available for general use. Three years ago he perfected the device, and since that time he has been trying to have it protected so that he shall not be robbed of the credit and the benefits of the invention.

The adoption of the joint resolution does not obligate the United States to buy the invention. If the committee of five eminent scientists decide that the Garabed is practicable, then the United States may, at its option, purchase from the inventor the exclusive right to utilize the discovery. The sum to be paid, in case the option to purchase is exercised, will be settled upon by a committee of even number, half of whom are to be selected by the Secretary of the Interior and the other half by Mr. Giragossian, and the verdict of this committee is to be subject to the approval of the Secretary of the Interior and the inventor. If the United States decides not to buy the invention, the rights of Mr. Giragossian remain, as guaranteed by the resolution.

It is significant that this man's enthusiasm, sincerity and intelligence so impressed the Committee on Patents and other members of the House that the resolution was adopted by a vote of 234 to 14. In the Senate it was approved without much debate, on the recommendation of the Patents committee. By this means the upper body relieved itself of being held up to ridicule in case the Garabed fails to demonstrate its inventor's claims.

Truth of Claims Remains To Be Proved

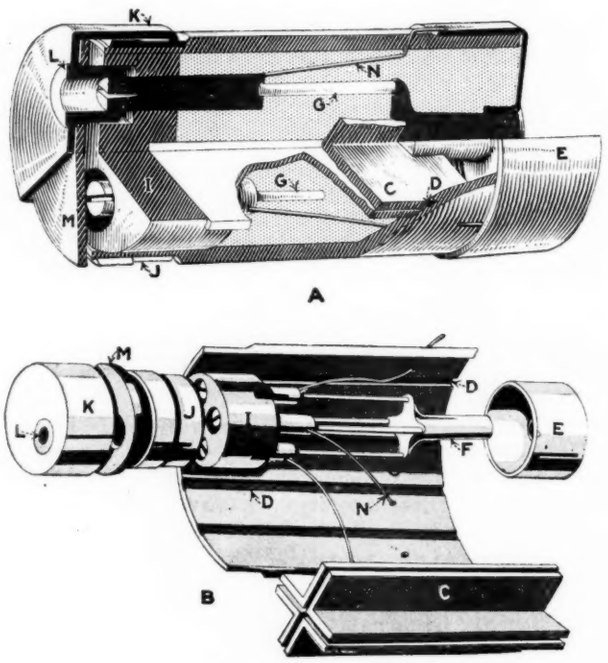
The ability of Mr. Giragossian to substantiate his assertions, by the exhibition of a motor that will run without the application of any of the commonly known forms of energy, remains to be proved. The inventor himself is confident and unperturbed, reiterating that he can and will do all that he has promised, and more. If he succeeds, as everyone would be glad to see him, the United States will have in its possession an agency by which the war can be brought to an end with stunning suddenness and certain victory; and in the peaceful years that will follow, the same agency will give to the nation an increase in material prosperity and happiness such as the world has never seen.

It is foolish to regard Mr. Giragossian as a harmless lunatic. That which he proposes is fantastic in the extreme and subversive of fixed ideas. But it must be remembered that people ridiculed the possibility of the airplane, the wireless telegraph and scores of other scientific discoveries that have now become familiar factors in everyday life. We are in an age of searching investigation and rapid development. The impossibilities of yesterday are the achievements of today; dreams of yesternight are realities tomorrow. It is unwise and unsafe to pass judgment on the discoverer of the Garabed. If he proves his assertions, the world will acclaim his genius and laud his perseverance. If he fails, his extravagant promises will be a boomerang that will knock him into the darkest corner of that limbo reserved for perpetual-motion cranks and other power-generating fakers.

Four-in-One Cartridge Fuse

No doubt many readers will recall the description of the Six-in-One plug fuse appearing in the July 11, 1917, issue of *Power*. Recently a four-in-one cartridge fuse, known as the Atlas fuse, has been placed on the market by the Atlas Selling Agency, New York City. A sectional view *A* and a view *B* of the fuse exploded are given in the figure.

From the outside this new type of fuse looks the same as the standard type of cartridge fuse and can be used anywhere that standard fuses are used. However, instead of a single chamber, as in the ordinary type of cartridge fuse, the inside of the shell is divided into four compartments by four pieces of fiber, bent and assembled as shown at *C* in both views. The fiber compartments fit into grooves *D* in the fiber-containing shell, making a very strong construction.



SECTIONAL VIEW AND PARTS OF FOUR-IN-ONE CARTRIDGE FUSE

One end of the fuse shell is equipped with a stationary brass cap *E*. From the center of this stationary cap is a copper extension *F* from which four fuse wires *G* run through the four separate compartments to four copper terminals *H* held in a short solid-fiber cylinder *I* at the opposite end of the fuse. On the end of the fuse shell containing the four copper terminals *H* and fiber cylinder *I* is placed a stationary brass ferrule *J*. Fitted over the stationary ferrule is a movable brass cap *K*, containing a copper receptacle *L* that fits over one of the copper fuse terminals *H*, as shown in the sectional view. This completes the circuit through the fuse from the movable cap *K* to the stationary cap *E*. The copper terminals *H* are slotted in the end that the receptacle fits over, to give them a spring and make a good contact in the receptacle.

If a fuse blows, all that is necessary is to remove the cartridge from the clips, pull cap *K* out about ¼ in. and give it a quarter turn, push back the cap and another fuse element is in circuit. Replace the cartridge in the

clips and the circuit is again ready for service. To prevent making contact with any fuse element other than the one that is intended to be in circuit, a fiber washer *M* is placed in the top of the movable cap *K*. The blowing of a fuse element is indicated as in a standard fuse, by a fine steel wire *N*, that extends from the copper terminal *H* to the stationary cap *E*. Each fuse element is solidly packed in its chamber with an insulating powder. This new type of fuse is approved by the Underwriters' Laboratory and is made with ferrule contacts in all amperages up to and including 60. All measurements and dimensions are N. E. C. standards, thus assuring a perfect fit in every type of N. E. C. standard panels, switchboard and inclosed-fuse cutouts.

Velocity of Air in Ducts

After the velocity head of air in a chimney or duct is found by means of a manometer or U-tube, its velocity is calculated by the formula,

$$v = \sqrt{2gh}$$

where v = velocity in feet per second, h = velocity head in feet, and g = acceleration due to gravity in feet per second = 32.16 feet.

When the manometer contains water and the velocity of air is being determined, the head must be changed from inches of water to feet of air by multiplying by the ratio of the density of water to that of air. To do this the temperature of each must be known, as the weight of a cubic foot of air or water changes with variation in temperature. To illustrate, assume that the manometer reading h (the difference in level) is one inch of water and that the temperature of the water and of the air is 60 deg. F. From standard tables, the weight of one cubic foot of water at 60 deg. is found to be 62.37 lb. and of a cubic foot of air at the same temperature is 0.0764 lb., or the height of the column of air in feet to represent the same pressure as one inch of water would be $\frac{62.37}{0.0764} \times \frac{1}{12} = \frac{816.4}{12} = 68.03$ ft. In other words, water is 816.4 times as dense or heavy as air at the temperature taken, so that a column of air 816.4 in., or 68.03+ ft., would equal or balance a column of water one inch high or that difference in level in the U-tube manometer. Then applying the equation, the velocity of the air is found to be

$$v = \sqrt{2gh} = \sqrt{2 \times 32.16 \times 68.03} = 66.2 \textit{ ft. per sec.}$$

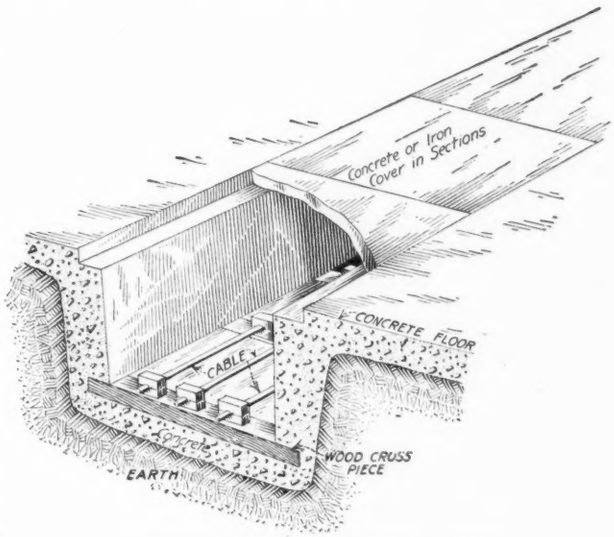
For any other temperatures, or if mercury is used in the manometer in the place of water, the proper weights per cubic foot will have to be used.

Installing Electric Cables Under Concrete Floor

By D. R. Shearer

Sometimes it becomes necessary to run heavy light and power cables under concrete for some distance, as for instance, from the generator to the switchboard in a power plant or from the transformers to the switchboard in a substation. Of course conduit is an excellent runway for such cables, but at times this is difficult to secure and some substitute becomes necessary.

An excellent method is to place a trough form in the earth floor before the concrete floor is laid. On the bottom of this form are placed cross-pieces of creosoted wood about three feet apart and slightly longer than the trough is wide. After the concrete sets the form is



SECTIONAL VIEW OF CABLE DUCT

taken out, leaving the cross-pieces embedded in the bottom of the cement trough.

The cables are then cleated to the cross-pieces with porcelain cleats and heavy screws. Either iron or reinforced concrete may be used as a cover for the duct. This can be removed at any time for cleaning the cables or attaching other leads. The figure gives a sectional view of the duct construction.

To Determine Heating Requirements

By M. William Ehrlich

Under the present stress it is more important than ever to provide adequate heat for the comfort of workers, lest quality and output be impaired. Suppose a case of a corner office or workroom that could not be heated satisfactorily although it had been figured by the old rule allowing one square foot of direct steam radiation to take care of 80 cu.ft. of space and accordingly a radiator having 30 sq.ft. of heating surface was installed. Experience has shown this to be wrong. The mistake was made in using a thumb-rule to arrive at the radiator size. This has often proved to be a dangerous procedure unless seasoned with judgment based on ripe experience.

The cubical contents of a room have but little to do with its heating requirements. They enter into the question only as regards air leakage or ventilation, and in direct heating this factor depends mainly on the infiltration of air leaking through the door and window crevices. This has been found to average one air change per hour when doors and windows are closed. When some form of ventilation is desired, more air may be admitted through windows or otherwise, and the radiators must be proportionately larger to take care of this air change in the room. The cubical contents of the room are therefore taken to represent one change of air an hour which is usually but a small portion of the

heating requirements, as will be shown. What does count, however, is the weather exposure and the materials used in the wall construction. The "exposure" is that part of the wall of a room or building which is subjected to the direct action of the outside weather, such as the walls, windows and doors facing on a street or other open space and also the roof. The chief heating work to be done depends on the losses through such exposed surfaces and is a component of the aggregate of such surfaces, their material and thickness and the difference in temperature between the indoor and the outside air. Thus, when it is —5 deg. outside and 65 deg. indoors, the difference is 70 deg., or with +10 deg. out of doors and 70 deg. indoors the difference in temperature is 60 deg. A temperature difference of 70 has become a standard for calculating radiator sizes in the eastern section of this country as well as elsewhere if climatic conditions are similar.

The demand on a heating system naturally varies with the fluctuations of the outdoor temperature, but the radiators must be selected to adequately serve the maximum difference in temperature. The total heat

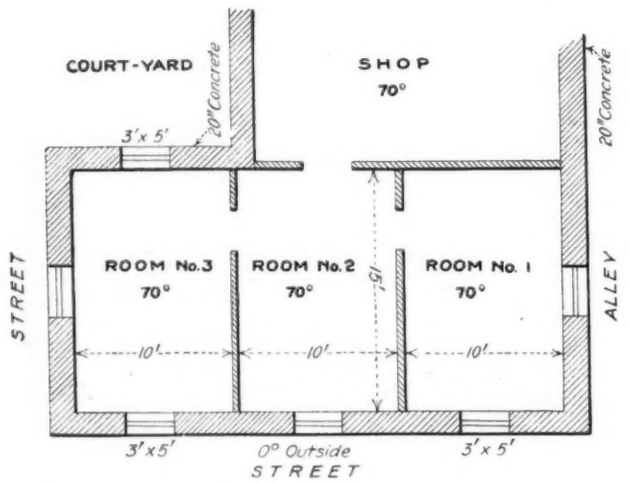


FIG. 1. CONTRAST IN HEATING REQUIREMENTS

loss for any condition is the sum of the transmissions through all the surfaces and for air change, for any difference in temperature between inside and outside air.

As an illustration take a room arrangement as shown in Fig. 1, where each of three offices adjoining has a cubical contents of 1500 cu.ft., or an inside measurement of 10 x 15 ft. with a ceiling height of 10 ft. The windows are 3 x 5 ft. each and the outside temperature is taken at zero while 70 deg. is maintained indoors. Room No. 1 has two outside walls, a gross exposure of (15 and 10 times 10 ft. high) 250 sq.ft. Two windows (30 sq.ft. of glass) deducted from 250 leaves 220 sq.ft. net for exposed wall. No. 2 has one (10 × 10) 100 sq.ft. gross wall exposed to the weather, less 15 sq.ft. for the window, leaving 85 sq.ft. net wall exposure. No. 3 has three sides 10 + 15 + 10 = 35 times 10 ft. high, or 350 sq.ft. gross wall exposed, less three windows, or 45 sq.ft., leaving 305 sq.ft. net wall exposure. With such great differences in the surfaces through which heat is lost, each room will require a different amount of radiation, but on the basis of cubical contents each would get a radiator of the same size or, say, 80 cu.ft. to one square foot heating surface would be 1500 ÷ 80 = 18¾ sq.ft. This, obviously, cannot be right for three such conditions.

To properly determine what the radiation should be involves a series of computations. To eliminate this figuring the chart, Fig. 2 (p. 225), has been prepared for low-pressure steam and hot-water heating by direct radiation and a difference in temperature of 70 deg. The use of the chart for practical purposes is quite simple as it is only necessary to know the material and thickness of the exposed wall as shown on the scale at line *A*, and the square feet of this exposure as shown on scale *B* In case of air leakage or ventilation this same scale is used for reading cubic feet of air per hour. With these factors determined by examination and measurement or from plans, it is only necessary to lay a straight-edge across from point to point and read the answer from scale *C* for either steam or hot-water heating, adding together the amounts so found for the final answer. For example, take a 16-in. brick wall that has an exposure of 190 sq.ft. net. What is the amount of radiation necessary to compensate for the heat loss through this exposure? Laying a rule across from scale *A* at the point marked for a 16-in. brick wall to 190 on scale *B* gives, as shown, an intersection at scale *C* at 13 sq.ft. steam or about 21 sq.ft. hot-water radiation. The wall exposure is, however, only a part of the total heat loss a radiator would be called on to compensate. The total heat requirement is, of course, the sum of the losses through all exposures and air leakage. In the case of the three rooms shown in Fig. 1 and assuming the outside walls are of 20-in. concrete, the radiator sizes for steam would be found, by the use of the chart, as follows:

	Determined from Plan, Fig. 1	Readings from Chart, Fig. 2, Sq. Ft. Radn.
Room No. 1:		
Net exposed wall	220 sq.ft.	23.0
Windows (single glass)	30 sq.ft.	9.7
1 Air change (contents)	1,500 cu.ft.	7.5
Total radiation		40.2
Room No. 2:		
Net wall	85 sq.ft.	9.0
Glass	15 sq.ft.	4.9
Air change	1,500 cu.ft.	7.5
Total radiation		21.4
Room No. 3:		
Net wall	305 sq.ft.	32.0
Glass	45 sq.ft.	14.8
Air change	1,500 cu.ft.	7.5
Total radiation		54.3

These values are all determined by placing a straight-edge from values on scales *A* and *B* and reading the answers directly from scale *C*. However, 1500, the cubical contents, is not on the chart, so 500 was selected of which 1500 is a multiple. For one air change and 500 cu.ft. the result on scale *C* for steam is 2.5 sq.ft. This multiplied by 3 gives 7.5 sq.ft. as the radiation required to compensate for air leakage. This same method may be relied on for any other values not found on scale *B*, which is limited to 1000. The different values found when added together give the size of radiator required for the given condition, then the nearest commercial size radiator or a pipe coil of the required capacity is made up.

By comparing the results found on a heat-loss basis with those of the thumb-rule ratio method, which gave only 18¾ sq.ft., it is seen why there would be difficulty in heating the corner rooms.

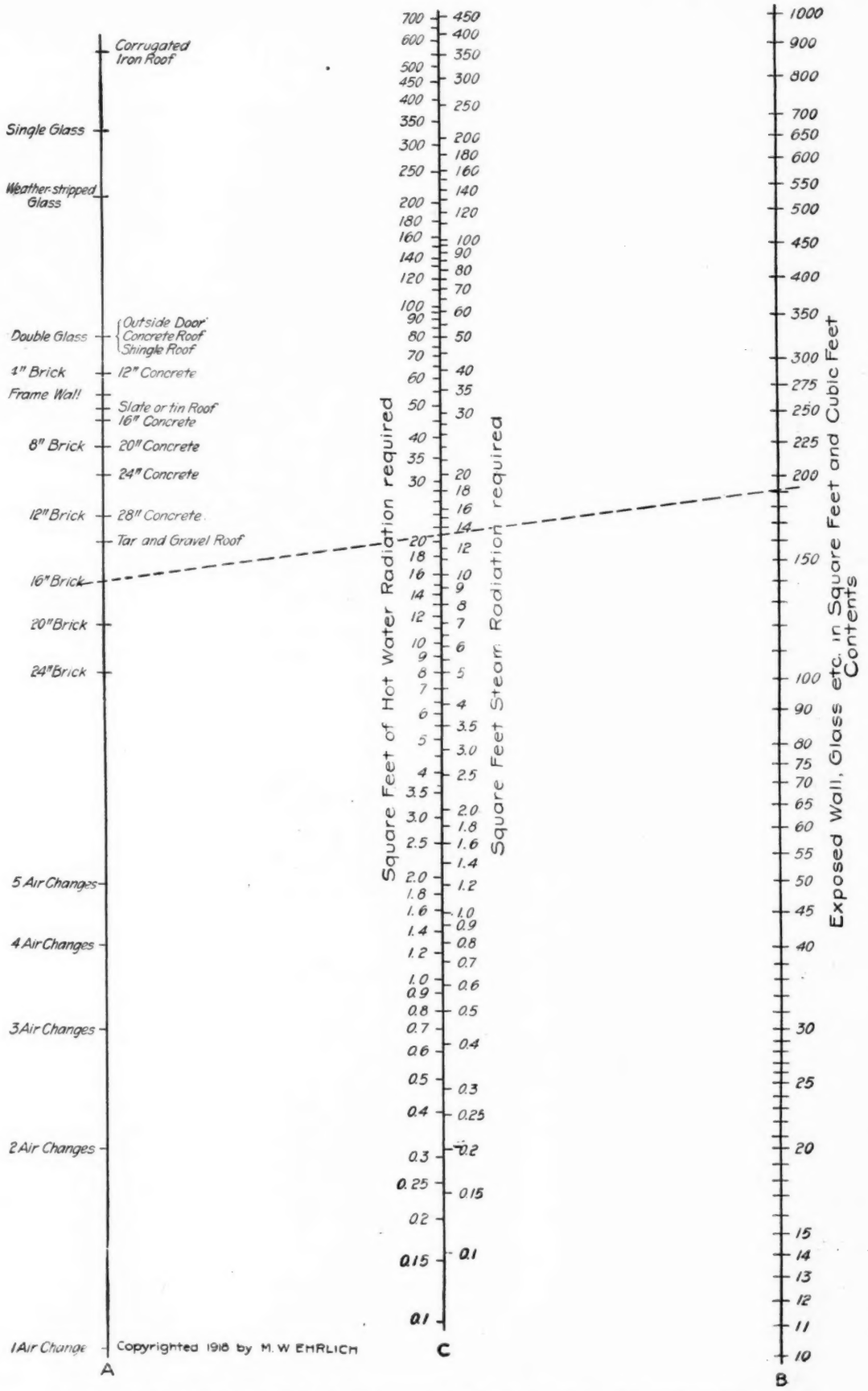


FIG. 2. GRAPHIC METHOD OF DETERMINING THE AMOUNT OF RADIATION REQUIRED

Self-Contained Portable Scoop Conveyors

The handling of coal from railroad cars to the storage pile is often expensive, and the more automatic and simple the apparatus can be designed the less the labor and operating cost involved. There are several types of portable conveyors manufactured, and among them is the portable scoop conveyor made by the Portable Machinery Co., Inc., Passaic, N. J., the design and application of which are shown in the accompanying illustrations.

This machine is of the belt type, and it may be driven either by a self-contained motor or by an internal-combustion engine. It is called a scoop conveyor because the conveying belt receives material through a scoop that can be pushed into the material to be handled. The machine, Fig. 1, is handled by one man in loading or unloading, stacking or reclaiming loose material, such as coal, coke and ashes, at a rate of about one ton per one and one-half minutes.

When used to handle from coal hopper cars, the scoop end of the conveyor is run in on the car and the coal can be elevated from the track level, a distance of from six to nine feet to a storage pile. One advantage of this machine is that by using two or more conveyors, as shown in Fig. 2, the coal can be elevated in successive stages until the storage pile has reached any desired height without the necessity of resorting to shoveling, thus saving in labor.

When used in reclaiming coal from a storage pile, the scoop end of the conveyor is pushed into the pile and the coal is discharged into the car for conveying it to the boiler room. If a storage pile is such a distance from the car track as to be out of the range of the machine, a second unit can be used, the first one discharging into the scoop of the second, which discharges in turn into the car. In this way the coal can be conveyed any distance, the only limit being the number of machines used.

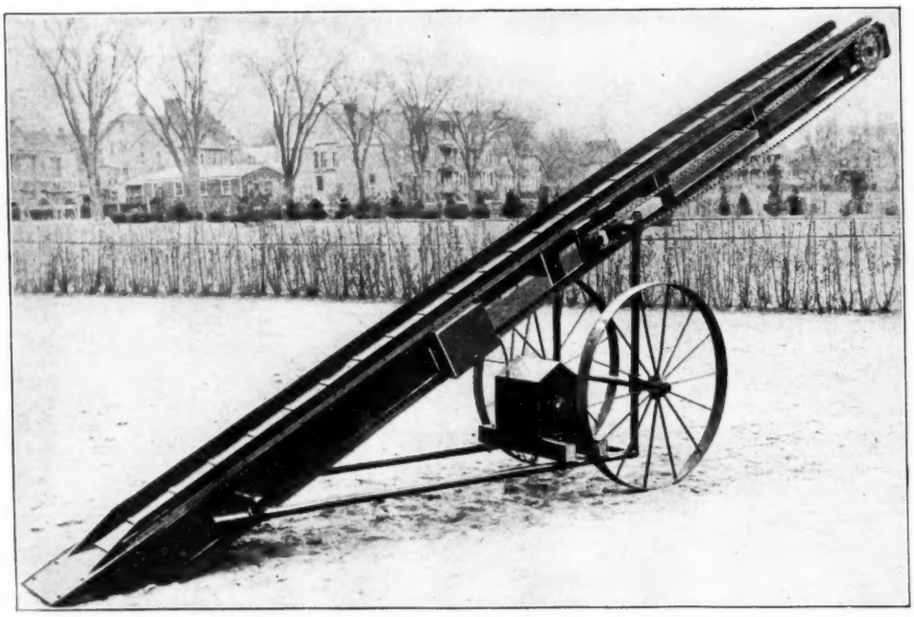


FIG. 1. PORTABLE SCOOP CONVEYOR WITH SELF-CONTAINED MOTOR

The conveyor is built of steel and is mounted on two wheels. The driving motor is mounted on a pipe frame, as shown in Fig. 1, and drives the belt by means of chains and sprockets. When the conveyor is to be moved, two lengths of pipe are inserted into the ends of the horizontal members of the pipe frame, which enables the machine to be easily wheeled from one place to another.

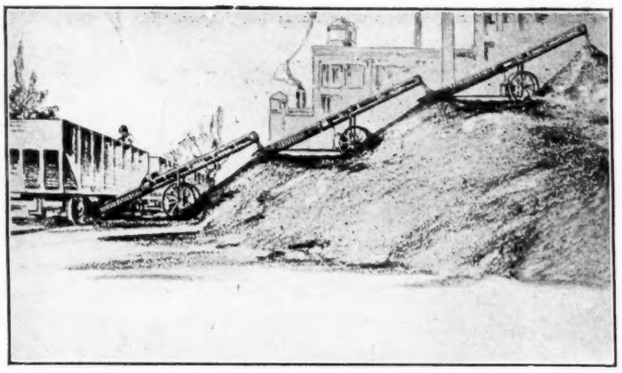


FIG. 2. UNLOADING CAR WITH THREE CONVEYORS

Handling Feed Water at River Station

It will be remembered that in the Feb. 13, 1917, issue of *Power* there was published a description of the River Station of the Buffalo General Electric Co., Buffalo, N. Y. One of the features of this station is the evaporator system for evaporating makeup water. The boilers are run at 300 to 400 per cent. rating, owing to the load demands increasing far more rapidly than plant expansion, the serious situation in load having been brought about by the withdrawal of water power by the Canadian government. The evaporator system has been in service now for nearly a year, and *Power* readers doubtless will be interested to know how the boiler-feed water is taken care of.

The evaporators (Reilly multicoil) are working up to the limit owing to the heavy overloads on the boilers, so that they are not able to supply all the makeup water; but they do supply on the average 98 per cent. of distilled water for makeup purposes. Once every month the water in each boiler is blown down so that the water level is lowered about three inches in the gage-glass. The boilers are opened once every six months, and so far the conditions observed have been excellent. There is no scale, and nothing but a slight amount of mud is found on the lower tubes. There is no pitting.

Editorials

The Solution of Greater New York's Coal Problem

"COAL-DOCK facilities are the key to the whole situation!" exclaimed Harry Peters, chairman of the Conservation Committee of the New York Fuel Administration, when interviewed on January thirtieth. And Mr. Peters is right. We concluded so ourselves, as pointed out in the article, "While the Idle Millions Shiver," in last week's issue. The thousands of tons of coal piling up on the rails at the coal docks or piers where great numbers of barges wait and wait, and the acute shortage in the greater city show instantly that here lie the causes of congestion and shortage.

There is another factor. According to New England Fuel Administrator Storrow the New England States consume forty-two million tons per year, two-thirds to three-fourths of which is ordinarily shipped by water, and most of it is delivered to New England during the six warm months of the year. The reserve supply in storage in these states is gone. Everybody's bin is empty. The industries and business houses in and about Boston must close, says Mr. Storrow, for a period two hundred per cent. longer during the crisis than the National Fuel Administration demands of the rest of the country. New England must make use of rail transportation to the limit of physical possibilities. This means throwing a severe overload on the coal piers located on the New Jersey shore and which also supply New York City, equally straining rail transportation from the mines to these piers and taxing barge transportation from the piers to southern New England.

New York City cannot escape being badly hit by the New England crisis and the great increase in ocean shipping from this port. New York City puts in only one-quarter to one-third of its coal during summer. The city has facilities for only four and one-half days' storage, chiefly because of real-estate values. Along in October the whole city suddenly demands coal, and in April the demand ceases just as abruptly. The unloading piers have been built and equipped to care chiefly for the usual demands of the Greater City. If the city is to be properly supplied, if New England is to be relieved and bunker coal furnished to the ships leaving New York harbor, the present piers are likely to be found to be wholly inadequate even if the whole eleven were worked day and night.

The report of the Conservation Committee upon its investigation of conditions at the eleven coal piers supplying New York City, published in our last week's issue, page 193, clearly reveals that the piers are not working at capacity, that they are inadequately equipped, undermanned and working but part time, considering twenty-four hour day operation imperative in this crisis. What is the good of rejoicing at the news in the papers each day that so and so many thousand tons of coal arrived at tidewater? It means nothing if the coal merely dribbles beyond that point.

But the conditions are more severe than is revealed by the report. The Conservation Committee says that for twenty-nine days last month the eleven piers together averaged 1335 cars unloaded per day, as against 1800 per day last year. So far as we can learn the railroads operating the piers say they can unload but 1300 per day. Their best performance was on January twenty-ninth, when they unloaded 1719. The Conservation Committee, the fuel administrators and the coal dealers know that unless the docks can average about 2000 cars per day, all hope of relieving the present situation is vain.

It is up to the coal-pier management to do this. If the local fuel administrators and the railroad representatives cannot get together and make these provisions at once, it certainly becomes the duty of Mayor Hylan and Governor Whitman to demand that Dr. Garfield and Director General McAdoo authorize someone to use a big stick here at tidewater.

The chief reason why the movement of anthracite is so slow at the piers seems to be lack of coal-pooling arrangements rather than physical impediments. According to the Conservation Committee it handed its report to A. H. Wiggin, Fuel Administrator for New York State, and to Dr. Garfield over a month ago, or on or about the date of its issue, which was December thirty-first. This report stated "that this committee recommends the pooling of *all coal* so that no additional time may be lost in switching." The italics are ours. Despite the urgent need of putting that recommendation into immediate effect over a month ago, only today (February fourth) have arrangements been put in force whereby barges may load with any coal available at the piers. And as this goes to press we are advised by the State Fuel Administration that this applies to three piers only; namely, those on the Delaware, Lackawanna & Western, Lehigh Valley and Erie railroads. It is hoped that they will go into effect for the other piers at an early date. The reader should understand that there is no pooling of anthracite as related to sizes.

There has been a considerable increase in demand for coal going over these piers, says the Conservation Committee. Twenty-five per cent. of the coal handled by them now goes to New England. Ships coaled in New York for transatlantic service must be provided with sufficient fuel to carry them across the ocean and back again, instead of one way only, as formerly done. It is likely, then, that at the capacity at which the piers are now worked the coal will continue to pile up in the yards, tying up more and more cars until a shortage of empty cars demoralizes mining. This is the very thing above all that should not happen through causes originating at this port. New York affords one of the best hauls in coal transportation. It is only a little over two hundred miles from the anthracite mines

and about three hundred from the bituminous mines to tidewater, and a short tow, about twenty miles, from tidewater to the city. It is New York City's vital concern how the coal piers supplying the city are equipped and managed.

While the Mayor logically looks to Mr. Wiggin, State Fuel Administrator, and to Reeve Schley, Administrator for Manhattan, also to the other administrators for the city, to keep him informed, he must appreciate that these gentlemen interest themselves chiefly in individual consumers' complaints and adjustments. It is a veritable riot of activity in the offices of fuel administrators the country over, so voluminous and varied are these pleas and "howls." The Mayor has wired and phoned to Washington for priority in shipment. New York does not need priority. If he will, through a representative who has investigated, concentrate his demands on improving the loading piers, he will get greater results.

The question of labor is by no means a negligible one at these piers. First, the function performed by labor there during this crisis is indeed a vital one. The work is not attractive. The piers are wind-swept and much of the coal is badly frozen. The men are paid, so far as we can learn, but thirty-five cents an hour. The pier management should not lose sight of the fact that the new shipyards and many other plants near all these piers employ tens of thousands of men and will soon demand more. The laborer in the section in which these piers are situated, particularly the laborer in Government work, is getting considerably more than thirty-five cents an hour.

Clear the coal docks in New Jersey, add to their discharging capacity. Relief cannot come until this is done and the railroads are unhampered by red-tape rules.

The Ammonia Situation

NOW it is an ice famine that confronts Greater New York. Senator Wagner and Former Governor Odell estimate that the Greater City faces a shortage of 2,500,000 tons. The State Legislature at this writing contemplates harvesting ice now while it is at its best, piling it on the banks of the Ashokan Reservoir, the Croton Lakes and other places, until storage houses can be built to hold it.

The reason is that New York City relies upon artificial ice for the greatest part of its supply. Ammonia is, of course, required for ice making. But the report is current that little of this refrigerant is or will be available because those products from which it is made are sorely needed for munition purposes and for Southern cities which cannot get natural ice.

All this sounds reasonable, particularly as related to New York City. Most of the ice harvested may be transported to the city by barge, which does not require freight cars nor add to the congestion on the railroads.

One thing is sure: It is difficult to overestimate the importance of an adequate supply of ammonia for refrigerating and ice-making purposes. Refrigeration plays a most essential rôle in our national life, a rôle that has not only enlarged tremendously in recent years, but has so changed our whole system of transporting, storing and consumption of foodstuffs that to try to abruptly effect a marked change in any of these would be followed by a calamity as great as, if not greater than the fuel crisis.

Now above all times there should be a full supply of ammonia on hand. In five or six weeks the winter will break and the load on refrigerated warehouses and cooling systems will rise like a kite string. The refrigerating plants should start each with a full charge of ammonia. One cannot hoard ammonia by overcharging the system, because compressor operation will not permit of it without prohibitive mechanical trouble. Because excess ammonia must be stored in drums in the average plant and because it is easily possible to keep a record of sales, hoarding should be easily prevented.

It will not do for the Federal authorities to be too hasty in withholding ammonia, particularly from warehouse companies storing food. Considerable discretion is not only desirable but imperative. Food is now under Governmental control. On the whole owners and operators of these warehouses do not own the food. They must not be driven or goaded to an attitude of irresponsibility—to a state of mind that would bring about a condition whereby the food stored might spoil due to a shutdown for lack of ammonia or other causes. With the Federal authorities in control of food and the essentials necessary to its preservation, and when someone else owns the food, it is not a far cry to unloading on the Government, to "passing the buck next door." These warehouses may properly be regarded as public utilities. But the Federal authorities cannot be unmindful of the fact that they present a totally different problem, as related to service interruptions, from that presented by railroads or the electric-power utilities, for example. These can pick up the load where they dropped it. A refrigerating plant rapidly reaches a critical stage once the refrigerant ceases to circulate through the system. While the rolling stock of the railroad and all freight except perishable, and the transmission lines and lamps of the electric utilities suffer no deterioration while the "power is off," the foods in cold storage immediately start on a road whose end is ruin as soon as the compressors are stopped.

Not until every source of the raw materials from which ammonia is made is worked to its limit, not until everything has been done to develop new sources, should ammonia be withheld. Happily, the Government, is preparing to manufacture ammonia on a great scale.

The Great News

THE article by Dr. C. R. Mann, on page 217, has a significance beyond that suggested by its title. Although irrelevant to the field of *Power*, it is good reading for anyone who is observing the direction in which things are drifting in these times, when so much that was regarded as immutable has broken loose from its moorings and so much that was apparently crystallized is in a state of flux.

If we are now to "envisage an entire community as a single working plant for the purpose of organizing it for the production of human wealth"; if industry and commerce are to be "organized to make goods cheap and men dear"; if "public service rather than excess profit is to become the inspiration for enterprise"—then indeed will "the engineer and not the banker become the power behind the throne" and the word efficiency take on a new and broader significance.

Correspondence

Peening Pipe in Its Flanges

A steam line that once came under my observation gave trouble by leaking at the threads in the flanges. To my knowledge it was taken down three times and the ends of the pipes calked against the flanges. If, instead, with a ball-peen hammer, the pipe had been peened into the flange and back for a distance equal to the thickness of the flange, the job would have been more successful.

Many engineers make a practice of heating the flanges before screwing them on a pipe, believing that when they cool the joint will be tight. So far I have failed to get good results that way, but have always made it a practice to see that the pipe is well peened into the flange. The pipe should be screwed in to come flush with the face of the flange. If one has a lathe, the flange can be turned off a small amount at the inside edge. The pipe can then be screwed in so it projects through, and after it is peened into the flange and the recess, it can be faced off with a file, making a job that will stay tight. N. C. GLEASON.

Northport, Wash.

Hoisting Boilers to Second Floor

The boilers in the new plant of the Studebaker Corporation at South Bend, Ind., weigh 30 tons each and had to be placed on the second floor twenty feet above street level. I secured a double-drum hoisting engine and rigged up two sets of blocks with a $\frac{5}{8}$-in. steel cable, fastened one end to an overhead beam in the building and the other to the boiler with cables and clamps. The leads ran from the upper blocks to snatch-blocks on the building column, thence down the column to the ground and through other snatch-blocks to the drums of the hoisting engine, all snatch-blocks being fastened to the building column with cable and clamps.

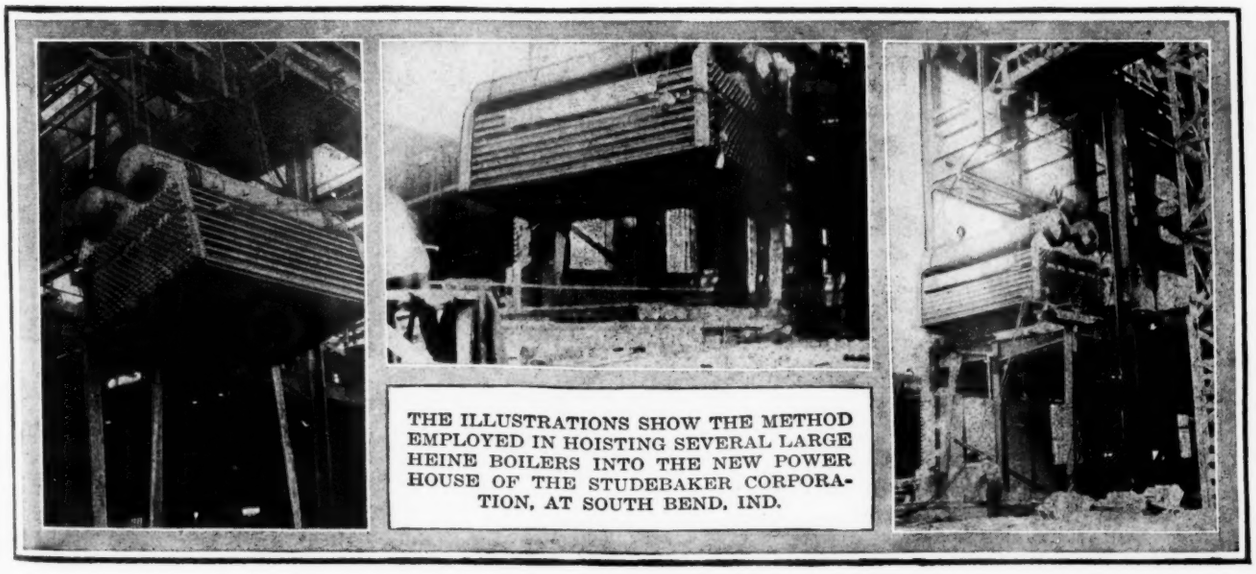
We hitched 1½-in. rope blocks to each end of the boiler to hold it away from the building and to let it come in gradually after hoisting it above the second floor. We also had a pair of skids from the ground to the second floor and two planks lashed to the tubes for the boiler to slide on, as it went up, to protect the tubes.

In hoisting, we raised each end six feet at a time until we had the boiler four feet above the second floor. We then slacked off on the rope blocks and placed two 14-in. x 14-in. x 20-ft. timbers under each water-leg, letting them extend five feet out from building. On these we put three rollers with a 3 x 12-in. plank on top of rollers and lowered the boiler to rest on these planks slightly and, with two rope blocks within the building, moved the boiler over into place. The time required after the rigging was set was just one hour to hoist and land each boiler, and there was no damage done to man or material on the entire job.

St. Louis, Mo. C. C. MULDNER.

Regulating Fuel-Oil Burners

I wish to add to the letter by Edward M. Walker, on page 807 in the issue of Dec. 11, regarding the proper method of regulating fuel-oil burners, that economical combustion is not assured unless strict attention is given to damper or air regulation, and in boilers of the B. & W. type using back-shot burners the proper place to observe the flame is through the small holes in the settings for soot cleaning, in the first pass opposite the second or third row of tubes where the end of the flame may be seen; then with the atomizer set so as to produce a clear flame, the breeching damper should be gradually closed until the end of the flame appears red



THE ILLUSTRATIONS SHOW THE METHOD EMPLOYED IN HOISTING SEVERAL LARGE HEINE BOILERS INTO THE NEW POWER HOUSE OF THE STUDEBAKER CORPORATION, AT SOUTH BEND, IND.

or slightly smoky. In this type of setting the flame is directed toward the front, and with a heavy fire curls back over the top of the main flame body, ending in the lower part of the tube bank; therefore no idea of the actual condition of the fire can be had by observations taken at the front—that is, through the fire-door—because the fire may be quite smoky either from insufficient atomization or a deficiency in the air supply, while the color of the main body of the flame is not noticeably changed, but a glance at the tip of the flame will plainly reveal the condition.

In some oil-burning plants the firemen are given instructions to so regulate the dampers that a faint haze will appear at the stack. The careless ones soon learn that by setting one fire so as to produce the haze the remaining boilers may be operated with the dampers wide open, thus saving them the trouble of regulating the dampers, and the chief or superintendent, seeing the haze coming from the stack, is satisfied. This little trick is often played on the CO_2 recorder when but one boiler is connected to it; that boiler is operated so as to give a good CO_2 reading, while the others are neglected.

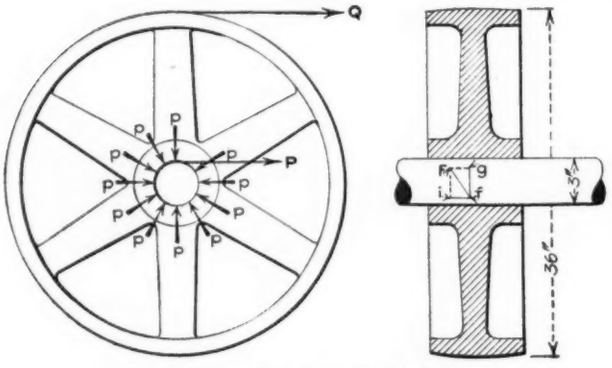
A. C. McHUGH.

Del Monte, Calif.

Why Twist the Pulley?

On page 808 in the issue of June 12, 1917, Sidney A. Reeve asks, "Why is it that in forcing a pulley on a shaft, you can gain by twisting the pulley?"

I think that this may be explained in the following way: Imagine you have a pulley 3 ft. in diameter on a 3-in. shaft, as shown in the illustration, and the pulley is pinched on the shaft by forces p. When a force F is applied to the pulley in order to force it along the shaft, the pulley will move as soon as F is greater than Σpu, in which Σp = sum of pressures p and u = coefficient of friction. When $\Sigma p = P$, then F must be greater than Pu. Let Pu be $fi = 300$ lb., then it will not be easy to succeed without twisting the pulley. It is much easier to turn the pulley round the shaft. You



PULLEY TO BE FORCED ON SHAFT

need but apply to the circumference of the pulley a force $Q = 300 \times \frac{3}{3}^{6} = 25$ lb., as this force corresponds with a force $fg = 300$ on the circumference of the shaft.

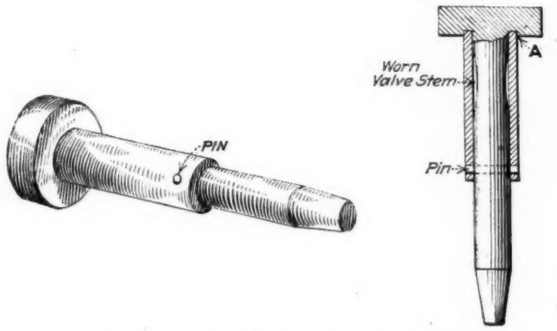
Suppose $Q = 24.9$ lb. or $fg = 24.9 \times \frac{3}{3}^{6} = 298.8$ lb. Then the pulley will not turn. At the same time we apply a force $fi = 32$ lb. in the axial direction. The resultant force will then be $fF = \sqrt{298.8^2 + 32^2}$, which is greater than 300 lb. In consequence the pulley will move in the direction of the resultant force fF; that is, it will turn round the shaft and move in an axial direction. If we apply a force $Q = 25$ lb., the force F, be it ever so small, will cause a movement in the axial direction.

This property might be taken advantage of with regard to measuring apparatus, where one wants to eliminate the influence of friction. If only we have at our disposal a turning force of sufficient strength, we can eliminate the friction in the axial direction.

Wageningen, Holland. Y. BROUWERS.

Repairing Worn Valve Stems

When the valve stems of a Corliss engine become cut or worn from the friction of the packing, it is expensive, especially in large engines, to replace them with new



VALVE STEM FITTED WITH SLEEVE

ones. If the stem is not worn to a dangerously small diameter, the following methods of repairing will be found inexpensive and efficient. The job might be repeated whenever necessary, thus retaining the same stems indefinitely.

The stem shown in the illustration is 2¼ in. diameter, with a tee-head 2¼ in. square. A piece of drawn steel tubing 2½ in. outside diameter and a scant 2¼ in. inside diameter, making a snug driving fit on the stem, was forced on over the valve stem to the position shown at A. The hole in the bracket was bored out ¼ in. larger, as was also the gland. The stem was then put in place and packed with packing ⅛ in. smaller than the old.

The job proved satisfactory and made the stem apparently as good as new.

If I were building an engine, I would have the stems provided with sleeves so that when worn they could be removed and replaced by new ones.

Passaic, N. J. CHARLES W. OAKLEY.

Removing a Key—Not

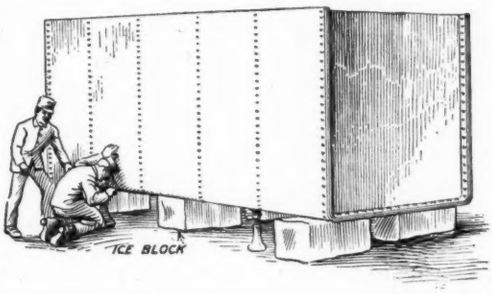
Of all the "fool stunts" I ever heard of, the following seems to be the limit. A self-styled expert machinery rigger, after sledging at a ⅞-in. key that had been exposed to the weather for years and failing to move it, looped a few turns of No. 10 galvanized wire around it and hitched a "flivver" automobile to it expecting to draw it out by a steady pull. Did he succeed? He did not.

B. C. WHITE.

Spartanburg, S. C.

Lowering a Heavy Tank

At a certain plant a large tank was to be lowered from an elevated position to the floor. The job proceeded smoothly by successively blocking and lowering with jacks, until at last the tank was resting on the jacks



LOWERING THE TANK TO REST ON BLOCKS OF ICE

with their bases on the floor. The problem then was to get it the rest of the way down. This was accomplished as follows: The tank was lifted slightly and blocks of ice placed under it. The jacks were then removed and warm water flushed around the ice and the tank gradually settled into place. J. M. PURCELL.

Richmond, Va.

A Groaning Steam Pump

Following is my experience with a groaning pump. It was a Worthington duplex 16 by 12 by 12 plunger pattern, and furnished water at 90 lb. pressure to operate three hydraulic elevators in a loft and office building. The surge tank of the system was in an out-of-the-way place under the floor. The awful groan drove the whole lot of us almost to distraction, including about 50 or 60 dressmakers on the fifth floor, and they threatened to quit. Of course, that would never do.

We located the groaning in the water end, and began feeding it soap suds, cylinder oil and graphite, etc., without satisfactory results, so we decided to operate. It was found that the two bronze plungers and the cast bronze sleeves (a snug fit) were cutting badly and something had to be done. We painted the plungers with graphite and cylinder oil, then went on a still hunt for the cause of the cutting and found the water in the cistern full of grit, scum, lath, lime, sand and cement that would neither sink nor float on top, but would stay suspended in the water. There was no provision made for emptying the cistern, but we soon had an ejector at work and had the cistern empty and thoroughly cleaned; after filling it with fresh clear water, we had no more trouble. R. A. PERRY.

Hayden, Ariz.

Why a Different Rate of Scale Formation?

I have picked up much useful information from *Power*, and by way of return I am sending the following on a subject I have never seen discussed, in the hope of stimulating investigation which may be well worth time and money to follow up.

As a boiler inspector I have often been struck by the different amounts of scale to be found in boilers using the same water and working under the same conditions, and on inquiry I find other inspectors have noticed the same thing, but without thinking further about it. Two cases in point are as follows: Of two locomotives made by the same firm, working at the same pressure, fed from the same water supply and working the same number of hours, one boiler shows practically no scale and the other is in a very bad condition with scale. In a battery of boilers all working under similar conditions as regards pressure, feed supply and time between each cleaning, one boiler has much less scale than any of the others, yet the man whose duty it is to look after the feed tells me that judging by the amount of water he puts into it, it must evaporate about twice the quantity of steam the others do.

I could cite many other similar cases, but these two are enough to show what is meant. My idea is that there is something in the composition of the plate which accounts for it. If this is correct, the task would be to find out what that something is and then to see that all future boilers were made with this material. Perhaps some readers may be able to confirm my statement.

Wigan, Lancashire, England. A. BENNETT.

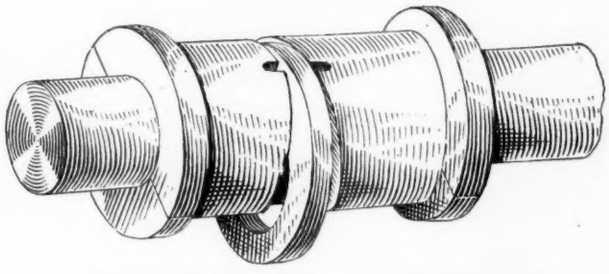
Keeping Lubricator Glass Clear

To keep cylinder oil from coming in contact with and adhering to the sight-feed glass of a lubricator, my practice is to insert a small strand of copper wire in the tube. This wire should extend to the top of the sight glass, but care should be taken not to have it so long as to come in contact with the top plug when it is screwed in. M. H. OSGOOD.

Woburn, Mass.

Improvement in Ring Oilers

The slot in the top half of ring-oiled bearings is sometimes made too wide for the ring and the oil is not carried to the oil grooves and consequently is not properly distributed. On the high-pressure end of turbines the heat from the casing and the steam makes the use of a heavy oil almost imperative, as the lighter



OIL-RING SLOT MADE WIDER AT BOTTOM

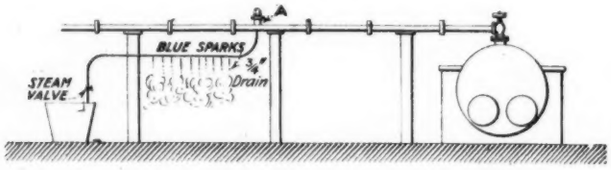
oils are "boiled out" of the reservoirs. A good grade of steam-cylinder oil follows up the oiling ring in a thicker film, but this necessitates a wider ring slot at the bottom, as shown in the illustration. I make it a rule to increase the width of the slot at the bottom to twice that of the top and find it a great improvement.

In using heavy oil, start the turbine slowly and give the oil time to get thoroughly warm and flowing freely.

Herkimer, N. Y. HAROLD G. BURRILL.

An Electrical Phenomenon

At the close of my apprenticeship days, many years ago, I had a peculiar experience never since observed, although it is said not to be unusual. It manifested itself in a curious manner and in such a way as might easily give a man of nervous temperament a shock not soon to be forgotten. I was at that period engaged upon the upkeep of the works plant which included, among other things, a 9 x 30-ft. Lancashire boiler carry-



PIPE LINE WITH BLEEDER PIPE THAT BURST

ing 150 lb. pressure and situated some distance from the works at the end of a field, where a new power house was to be erected. Steam was sent across the field through an 8-in. pipe supported about seven feet above ground to supply the existing works engines, and at a point *A* about midway in the line there was a branch taken vertically and then horizontally at right angles to the main pipe line across to another part of the works, where other engines were situated.

At the base of the tee there was a ¾-in. pipe attached to act as a drain and also to feed a tank for boiling suds. It was the custom to shut the steam off this pipe line at night and turn it on again early in the morning. On this particular morning in January, during a spell of extremely "black frosty" weather, on starting up it was found that the ¾-in. drain pipe had frozen solid during the night, and it had to be allowed time to thaw out, which occurred about 6:30 a.m., but the frost had split it all along one length of pipe so that after it had thawed out, steam issued from the split into the cold air of the early morning with a high velocity and a tremendously shrill noise. This in itself was not so alarming, but the phenomena accompanying it presented a startling appearance, for, at a distance of about three inches from the split seam, and at that point where the steam began to show itself expanding into a visible vapor, there was a steady stream of heavy blue sparks having a comb-like appearance, apparently jumping across the air space from the pipe to the vapor, the effect being accentuated by a crackling noise not unlike continuous musketry firing at a distance.

When called to my attention, I naturally experienced an uncanny feeling, intensified by the frightened tones of my informant, but soon decided what the cause was. The blue sparks were discharges of static electricity produced by the friction of dry steam slightly superheated passing through cold dry air at a high velocity. Upon closer examination the discharge was found to be taking place actually where the expansion of steam was visible. Detailed information will be found in textbooks treating of electricity and magnetism regarding such phenomenon.

Such electrical effects are also met with by engineers in other forms. A fireman vowed that he got a shock upon touching the mechanical stokers, and it was found to be caused by the dry driving belt running at a high velocity, for upon holding the hand near the inner side of the belt a thick bluish spark leaped across the air space from the belt to the hand, giving the experimenter a sharp but not dangerous shock.

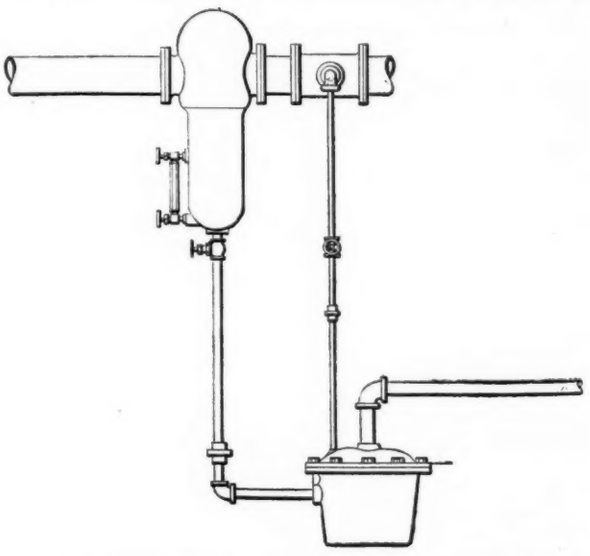
Electrical effects of this nature are met with in paper making. Paper is passed from the wet stage onto steam-heated revolving cylinders, then put through heavy calendering rolls so as to glaze the surface somewhat. This last process creates a static discharge, with its crackling noise, tending to distort the paper as it is being wound on to rolls. To prevent this distortion, a crude but satisfactory method is adopted; that is, two or three pails of water are placed upon a plank, spanning the machine, vertically over the point of exit of the paper from the rolls, and into each pail is inserted some loose strands of cotton rope or other material hanging well down below the bottom of the pails. The capillary action of these wick siphons is sufficient to distribute drops of water at regular periods into the air space between the paper and rolls, which is enough to dissipate the electrical discharge.

Doubtless other engineers know of many such instances, but perhaps under different conditions.

London, N. W., England. HENRY S. WHITELEY.

Trapping Water from Air Line

In a plant furnishing compressed air for various processes of manufacturing, a great deal of complaint was occasioned by the moisture in the air, especially during damp weather. A separator "helped some," but



TRAP CONNECTED TO SEPARATOR ON AIR LINE

there was difficulty in trapping the water from the separator and it was necessary to leave a small drip or bleeder open all the time, as the trap did not work right; consequently, there was considerable loss of air at times and at other times the water would accumulate faster than the bleeder could take care of it. The difficulty with the trap was caused by its becoming air-bound, so the engineer drilled, tapped and connected it as shown in the illustration, with the air main allowing the air to flow back to the main, and no further difficulty was experienced. C. W. OAKLEY.

Passaic, N. J.

Inquiries of General Interest

Strength of Manila Rope—What is the breaking strength of ½-in., ¾-in., 1-in. and 1¼-in. diameter Manila rope? I. P.

New well-laid Manila hemp rope, ½-in. diameter, should have an ultimate strength of at least 1900 lb.; ¾-in., 4100 lb.; 1-in., 7100 lb.; and 1¼-in., 10,900 lb. But for ordinary uses the working stress of ½-in. diameter rope should not exceed 50 lb.; of ¾-in., 112 lb.; of 1-in., 200 lb.; and of 1¼-in., 312 lb. Greater working stresses cause the rope to rapidly deteriorate in texture and strength.

Grate Openings for Smaller Size of Coal—For using a smaller size of coal with forced draft we are using the herringbone grate bars with ⅜-in. openings formerly used for burning buckwheat size of coal, and considerable trouble is experienced from coal falling through the grates after each cleaning. What size of grate openings should be used? E. T.

The smallest slot form of openings practicable for ordinary forced draft are ⅛ to ¼ in. wide. By first spreading the grates with the coarsest fuel that is retained in cleaning, a minimum amount of fresh fuel will drop through.

Steam Consumption and Weight of Feed Water—In stating steam consumption in pounds, is this calculated from the number of pounds of feed water evaporated? B. C. M.

Unless otherwise qualified, steam consumption stated in pounds refers to the weight of dry saturated steam supplied at some particular pressure. Computation of the weight consumed can be made from known weight of feed water that has been evaporated and supplied as steam with deduction of the percentage of moisture in the steam delivered or of the percentage of moisture above the stipulated percentage. The weight is only to be considered identical with the weight of the boiler-feed water when the steam is delivered as dry saturated steam or if it is superheated or it has the specified percentage of moisture.

Cost of Coal per 1000 Cu.Ft. of Steam Generated—Where the actual evaporation of a boiler is 8 lb. of water per pound of coal into steam at 100 lb. gage pressure and the cost of the coal is $8 per ton of 2000 lb., what is the cost of coal per 1000 cu.ft. of steam generated? H. L. Y.

The cost of coal would be $8 ÷ (2000 × 8) = $0.0005, or 1/20 of 1c. per pound of steam generated. Assuming that the feed water is converted into dry saturated steam at a pressure of 100 lb. gage or 115 lb. per sq.in. absolute, then, according to the Marks and Davis Steam Tables, the density of the steam or weight per cubic foot would be 0.2577 lb. Therefore 1000 cu.ft. would weigh 1000 × 0.2577 = 257.7 lb., and the cost of coal required would be 257.7 × $0.0005 = $0.12885, or practically 13c. per 1000 cu.ft. of steam generated.

Space Occupied by Coal—How many cubic feet should be allowed per ton of coal? W. E. T.

The weight per cubic foot and consequently the number of cubic feet per ton varies with size, and uniformity of size to which the coal is broken, and also depends upon whether the coal is "shaken down" in bulk as by transportation and on the specific gravity of the coal, which varies for different mines and for coal taken from different parts of the same mine. Hence there is considerable variation in the cubic feet per ton, and further confusion arises from misunderstanding of whether "long" tons of 2240 lb. or "short" tons of 2000 lb. are under consideration. The average weight of American anthracite, taken in boxes holding 2 cu.ft., has been quoted as 53.4 lb. per cu.ft. and of Maryland and Pennsylvania bituminous coal as averaging 52.8 lb. per cu.ft., from which a short ton of anthracite would occupy 2000 ÷ 53.4 = 37.45 cu.ft. and a long ton 2240 ÷ 53.4 = 41.94 cu.ft.; and a short ton of bituminous coal would occupy 2000 ÷ 52.8 = 37.87 cu.ft. and a long ton 2240 ÷ 52.8 = 42.42 cu.ft. On account of the wide variation of conditions, no estimates of weight of coal from measurements of bulk should be regarded as more nearly approximate than within about 10 per cent. To be on the safe side, provision for space for storage of coal should allow not less than about 40 cu.ft. per ton of 2000 lb. and 45 cu.ft. per ton of 2240 pounds.

Relative Efficiency of Copper and Iron Heating Surfaces—What is the relative efficiency of coils made of iron or of copper tubes for heating water by a gas flame? F. M. E.

Copper coils are more durable than coils made of iron or steel pipe, and while the material is bright and clean the rate of transmission of heat to the water is several times as rapid as with new iron or steel pipes of the same size and arrangement. But coils of copper heated by gas quickly become coated with a deposit from the products of combustion that renders the copper surfaces no more efficient than similar iron-pipe heating surfaces that have been in use for the same length of time. Tests of two fire-tube boilers made alike, excepting that one had iron fire tubes and the other copper fire tubes, showed that their evaporative activity was practically the same.

Explanation of Formula for Use with Throttling Calorimeter—What is the explanation of the formula for determining the fraction of dryness of steam with the throttling calorimeter? A. L.

So far as practical results are concerned, the steam in the throttling calorimeter contains the same number of heat units per pound as the steam in the pipe from which the sample is taken; and since the original steam contains more heat per pound than necessary for dry saturated steam at the low pressure in the calorimeter the latter is superheated; that is, contains more heat per pound and is of a higher temperature than if it were dry saturated steam at the low pressure.

The specific heat or heat required to raise one pound of superheated steam through one degree when near the pressure of the atmosphere is commonly taken as 0.48 B.t.u. per pound, hence if t_2 is the temperature indicated by the thermometer and t_1 is the temperature of dry saturated steam given by the steam tables for the pressure existing in the calorimeter, then the steam is superheated $(t_2 - t_1)$ degrees and the B.t.u. absorbed as superheat by each pound of steam would be $0.48\ (t_2 - t_1)$. Hence if H = the total heat of a pound of dry saturated steam at the pressure that exists in the calorimeter, then the number of B.t.u. contained by each pound of the steam in the calorimeter would be $H + 0.48\ (t_2 - t_1)$, and this same quantity of heat is assumed to be present in each pound of the initial steam. The whole of each pound of the original water must have been heated to the boiling point while only a fraction of a pound may have received the latent heat of evaporation. Hence, if for a pound of the initial steam h = the heat of the liquid, L = the latent heat of evaporation, and q = the fraction of the whole pound that is dry saturated steam, then for a pound of the initial steam the B.t.u. present would be $h + qL$, and as the heat per pound of the initial steam is assumed to be the same as the heat per pound of the steam in the calorimeter, then

$$h + qL = H + 0.48\ (t_2 - t_1), \text{ or } q = \frac{H + 0.48\ (t_2 - t_1) - h}{L}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Storage and Weathering of Coal*

By W. D. STUCKENBERG and J. F. KOHOUT
Commercial Testing and Engineering Co., Chicago

During the present international complications the storage of coal is becoming increasingly necessary. The prime purpose, of course, is to have a supply of fuel on hand so that plants will not be shut down and homes will not be without heat. Another reason is the occasional, at the present almost universal, lack of railroad equipment to move the coal from its source to the ultimate destination. Labor troubles also interfere with the production or handling of coal, either at the mine, in transit, or in the cities.

ONE OF the theories now being advanced for the relief of railroad congestion and mine running time is to require large consumers, who are under annual contracts, to accept their coal in equal monthly shipments. This practice, if instituted, will necessitate storing coal when the deliveries are in excess of daily demands. The storage thus accumulated will have to be used at times when shipments are less than daily consumption.

Broadly speaking, the larger sizes of coal from about No. 3 nut on up through the various sizes of nut, egg and lump store without giving any trouble. This is due to the fact that these sizes are drier and offer a smaller surface, in proportion to their mass, to the action of oxygen than do the finer sizes.

Anthracite and semibituminous coals store well in any size, but this is probably due to their chemical composition. Oxidation occurs here also, but is much slower in action, and, therefore, smaller in amount for any given length of time. Sub-bituminous coal from the West, frequently called black lignite, is hardly suitable for storage. Its tendency to slake condemns it.

Finer Sizes High in Moisture and Iron Pyrites

The finer sizes of coal, which are used principally for power purposes, are generally high in moisture and iron pyrites. These are deleterious ingredients because of the ease of oxidation of the pyrite in the presence of water vapor. The finer sizes, that is, coal passing through 2-in. screen and smaller, expose a great number of small surfaces to the air. These several factors all tend to initiate oxidation and to speed it along once it has started.

Here also the difference between Eastern and Western coals should be explained. The former are much purer in that they are low in moisture and pyrite. The Western coals are much higher in both of these constituents and are therefore to be considered as being much more liable to spontaneous ignition. As an illustration of this peculiarity, a quantity of screenings from southeastern Kentucky was in storage for seven years, but when it was moved there was no visible evidence of excessive oxidation or deterioration. On the other hand, a storage pile of western Kentucky screenings may fire easily within 60 days.

Storage piles vary in size from a few tons to many hundred thousand tons. This fact necessitates a careful consideration of the three methods of storage—under water, in closed bins and in open piles. Under water any kind and size of coal may be kept for any length of time without danger from fire. This method is used by large consumers who also hold coal in open piles for immediate use. Storage in closed bins is generally limited to small quantities of fuel.

The great bulk of storage coal at present is kept in open piles. It is intended to be held readily available for use, and is seldom on the ground for more than a few months. As a matter of fact, it should not be kept long, but the length of time should depend on the kind of coal, since this is the most dangerous form of storage. However, when proper precautions are taken at the time the coal is placed on the ground and maintained while the pile lasts, losses may be eliminated or reduced to a minimum.

The losses which occur may be considered to be due to oxidation. It should be borne in mind that the rate of oxidation increases with the temperature, also that coal is a poor conductor of heat, so that much of the heat occurring or generated in the interior of the pile stays there. These two facts indicate that when oxidation starts, even though at a low temperature, it generates a small amount of heat. This heat is insulated from the outside air and, being retained, tends to increase the rate of oxidation. This one action helps the other, and the oxidation proceeds at a constantly accelerated rate, the more easily oxidizable compounds or constituents being attacked first.

Iron pyrite is oxidized in the presence of water to ferrous sulphate and sulphuric acid according to the equation expressed in plain English,

Iron pyrite + oxygen + water = Iron sulphate + sulphuric acid + heat.

This reaction takes place with a considerable evolution of heat. It is true that the oxidation really goes farther with the evolution of still more heat, but this additional heat, and also the heat due to the action of sulphuric acid on lime or alkalies present in the coal, or the heat generated by the dilution of the acid with water, are not considered. It must be remembered that the water actually enters into chemical combination with the pyrite and oxygen, unless the water is present in sufficient amount to exclude the air. This is the condition that prevails in under-water storage and is one of the reasons why that method is best.

When coal is stored in the dry state, the equation for the oxidation of the pyrite previously given is incomplete, since the moisture component is absent. When it is stored under water, the equation is again incomplete, because the air is thus excluded and the oxygen component is absent.

In other words, the oxidation of coal in the dry state proceeds very slowly, since the only moisture available is that in the coal and in the air. In dry coal the moisture is very low, so in dry storage one of the necessary constituents of the reaction is lacking to a relatively large extent.

In several instances which have come under observation a low-volatile coal, called "Arkansas semi-anthracite," has given considerable trouble from spontaneous combustion. This coal has a fairly large content of sulphur and low moisture. Its principal use has been as a substitute for semibituminous or Pocahontas coal for domestic use; and when it is unloaded from wagons into basements, it is generally sprinkled with a garden hose to lay the dust. This supplies the moisture which is necessary for the oxidation. Several fires have occurred in Chicago from this cause, and the fact that the coal is used so much in dwellings makes extreme care in its storage and handling absolutely necessary. It has not been on the Chicago market long enough to demonstrate if it would heat up in the dry state, but theoretically it should give no trouble in such a condition.

How the Temperature of the Pile Is Raised

The heat due to the oxidation of pyrite, helped by that coming from external sources, if any, raises the temperature of the pile to the point where the carbon and hydrogen of the coal begin to be attacked. This action is aided by the fact that coal, particularly when freshly mined, has a strong affinity for oxygen. The oxygen is absorbed much as water is taken up by a sponge. This supplies the oxygen needed for the oxidation of the carbon and hydrogen. The action is not likely to occur until a temperature of about 250 deg. F. is reached. The temperature of the coal is raised by these processes until it reaches a point (about 450 deg. F.) where the action is autogenous and is no longer dependent upon external sources of heat to maintain

*Excerpt from paper read before the Kentucky Ice Manufacturers' Association.

the temperature. When the temperature mounts up to about 750 deg. F., the coal takes fire.

Paradoxical as it may seem, the fact must be kept in mind that small amounts of moisture assist in the oxidation of the coal. This was tested out by Professor Parr at the University of Illinois. His bulletin No. 46, "The Spontaneous Combustion of Coal," giving the results of his experiments, shows without exception, in all the series of tests, that the wetting of the coal increased the activity, as shown by the ultimate temperature. Thus, when a storage pile is burning, it must be flooded with water to extinguish. Merely wetting the surface or outer layers of coal with a hose or spray will hasten the loss.

Heat from External Sources

In connection with piles of coal in storage, the effect of external sources of heat is of extreme importance. Without the aid of heat from some external source, the initial stages of oxidation either would not occur or their rate would be extremely slow. These sources may be steam pipes in the ground or near the pile, as in conduits, etc., which are in contact with the coal, or the heat from boilers. This last is particularly true in the case of bunkers on vessels. In one case that came under observation, a pile of coal which ordinarily stores without trouble, ignited. The cause was finally discovered in the presence of a manhole covered with a thin layer of earth, and so overlooked, through which steam passed. This manhole was immediately under the pile of coal and was the means of supplying enough heat to start the oxidation of this coal.

When coal is unloaded by dumping on the ground from a car or a high trestle and then is piled up to almost the level of the car floor, as is frequently done in the coalyards, the heat of impact and of pressure constitutes a positive danger to the coal.

The question is often asked as to the best season of the year to store coal. As far as possible coal should be placed on the ground in the winter months. It is then cold and fairly dry. The heat of impact and pressure, due to unloading and piling, while present, will not raise the temperature of the coal to any noticeable degree, and certainly not to the temperature of ordinary summer weather. Of course the coal must be free as possible from snow and must be unloaded on an area from which the snow has been carefully removed. One plan worked out for a consumer was to put down about two or three months' supply in September, October and November, then when the first of January came around to pick up this storage and let the daily shipments be put down for the fresh storage to be used in the spring, when labor troubles would disturb production.

Absorption of Sun's Heat

Absorption of heat from the sun will also raise the temperature of the coal to a surprising degree. This was noticed particularly at a plant in Chicago that was receiving coal direct from a mine in Indiana. The coal carried a rather large amount of moisture and pyrite, but was taken out of the ground only about ten days before delivery. When received, it was so warm that the hand could not be kept in contact with it for more than a few seconds. The reason for this was discovered in the fact that it was shipped in steel cars which stood on sidings exposed to the direct rays of the sun for about two days. The steel absorbed the heat readily and so raised the temperature of the coal. If this coal, instead of being passed directly to the furnace, had been placed in storage in the condition in which it was received, undoubtedly it would have fired spontaneously in a short time.

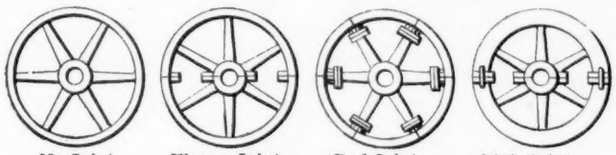
Oxidation or weathering of coal decreases the heat value. The loss is brought about by the oxidation of carbon and hydrogen to carbonic acid and water, which escape as gases. There is also an increase in weight of the coal due to the absorption of oxygen. This oxygen replaces combustible matter and acts like so much ash. In fact, the United States Bureau of Mines has shown in Bulletin No. 29, "The Effect of Oxygen in Coal," that oxygen and ash are of very nearly equal anticalorific value. Oxygen also interferes with the coking quality of coal, and a coal that has weathered to any great extent has either entirely lost its coking quality or at any rate will make coke of inferior quality. In addition, coal will disintegrate under the influence of oxygen, and the larger pieces will break up. In fact, the recommendation has been made that coal a size larger than that ordinarily burned at the partricular plant should be stored, so that when the storage coal is burned it will not be too fine for use.

This discussion of the effects of oxidation leads to a consideration of some of the precautions to be taken to prevent or minimize them. One scheme used in this connection had the opposite result. This consisted of two perforated pipes placed down in the pile. The idea evidently was to ventilate the interior and to provide for the escape of heat, should it be generated. However, one of the pipes, which happened to be about two feet higher than the other, acted as a stack, while the lower pipe served as an intake for fresh air. The odor of coal gas and of the products of combustion was clearly perceptible at the top of the higher pipe. Thus what was intended to check combustion was really furthering the oxidation of the coal. To minimize oxidation the following precautions should be taken:

1. Avoid external sources of heat that may in any way contribute toward increasing the temperature of the mass of the coal.
2. Eliminate coal dust and fine coal as far as possible.
3. Store dry coal and keep it dry.
4. Put the coal on the ground in a dry, clean place on as clear and cool a day as possible.
5. Do not pile the coal too high. Shallow piles afford the best chance for the escape of heat from the interior.
6. Store as large a size of coal as possible.
7. Store under water if possible and be sure the coal is completely submerged.
8. Watch the interior temperature of the pile with a thermometer, and as soon as any abnormal rise in temperature occurs, mark that spot as the next one to be drawn on for fuel, or if the conditions seem serious, overhaul the pile at that point and flood it.

Safe Speed for Cast-Iron Flywheels

The following table of safety speeds for cast-iron flywheels has been prepared by William H. Boehm and published in the *Operative Miller*. The margin of safety at the speed given is considered to be approximately three:



No Joint 100 Per Cent. | Flange Joint 25 Per Cent. | Pad Joint 50 Per Cent. | Link Joint 60 Per Cent.

TYPES OF WHEELS AND THEIR MAXIMUM EFFICIENCY

Diameter in Ft.	R.P.M.	R.P.M.	R.P.M.	R.P.M
1	1,910	955	1,350	1,480
2	955	407	675	740
3	637	318	450	493
4	478	239	338	370
5	382	191	270	296
6	318	159	225	247
7	273	136	193	212
8	239	119	169	185
9	212	106	150	164
10	191	96	135	148
11	174	87	123	135
12	159	80	113	124
13	147	73	104	114
14	136	68	96	105
15	128	64	90	99
16	120	60	84	92
17	112	56	79	87
18	106	53	75	82
19	100	50	71	78
20	95	48	68	74
21	91	46	65	70
22	87	44	62	67
23	84	42	59	64
24	80	40	56	62
25	76	38	54	59
26	74	37	52	57
27	71	35	50	55
28	68	34	48	53
29	66	33	47	51
30	64	32	45	49

If the revolutions given in the table be increased 20 per cent., the margin of safety on speed will be reduced to two and one-half; if the revolutions be increased 50 per cent., the margin of safety will be reduced to two.

Hydro-Electric Development*

THE introduction of electricity as a means for transmitting power over considerable distances and its subsequent rapid development completely changed the status of hydraulic power. Previously, such power could be used only near falling water. Now it is commercially available in convenient form within a radius, in some instances, up to 200 miles, a fact that has made it possible to utilize water powers even when located in remote and inaccessible places. Indeed, today practically all hydraulic-power developments of any magnitude are hydro-electric.

In the light of the foregoing it might seem reasonable to suppose that a large proportion of the modern demand for electric current would be supplied from the energy in falling water. Such, however, is not the case. Accurate statistics are difficult to obtain, but some approximate totals may prove illuminating. It has been estimated by a careful engineer that in 1911 there were over 26,000,000 steam-engine horsepower capacity in use (including railroad locomotives) in the United States. The aggregate water horsepower developed and undeveloped has been computed as around 60,000,000. Of this latter the United States Census of 1912 gives 4,870,000 as developed, and in a report of January, 1916, the Secretary of Agriculture estimates this total to have been increased to 6,500,000. Making liberal allowances for correction in these several figures, it seems probable that there are in service from four to five times as many steam as water horsepower and that there are still undeveloped water horsepower equal to at least twice that of all the steam capacity in service.

Steam- and Hydro-Electric Power Compared

There are two fundamental causes which have militated against the substitution of hydro-electric for steam-electric power. One is economic and permanent; the other is statutory and therefore subject to modification. Both reasons apply to some powers, but neither, fortunately, to all. The economic and permanent reason is high cost of development due to natural conditions. Electric power generated by falling water is inferior to that generated by steam in every particular except cost, and therefore water-driven service must be cheaper than steam-driven in order to justify its existence. The price for service depends primarily on cost, and cost divides itself naturally into two main items, namely, operation (including maintenance) and fixed charges. As a hydro-electric plant consumes no fuel, its operating cost is less than that of an equivalent steam-driven plant. On the other hand a steam plant costs usually only from one-fifth to one-half as much per unit of capacity as a hydro-electric plant, so that the latter must carry very much heavier fixed charges.

This disability of water service is usually even greater than the ratio of the costs of two equivalent complete developments. When steam is to be the motive power, only such capacity is installed as initial demands require, and the cost per unit is fairly proportional to that of the ultimate development. In a water development, a large part of the cost is for riparian rights, for the dam, flume, forebay, etc., and for the transmission right-of-way, towers, etc., which must be at the start largely provided and constructed for the complete installation. The obvious result is a greater fixed charge per unit of capacity and a higher cost per horsepower delivered for sale.

In forecasting the commercial prospects of a power enterprise, the possible market must be studied and, of course, a sale price for power decided upon. As this price is controlled by the cost of similar service from other sources, usually from steam, and as it must be attractive from the start, the additional burden of fixed charges on the initial part of a hydro-electric installation frequently forces the sale of its power below cost. The projectors of the enterprise then must rely for success on a sufficient subsequent increase in their markets. The possibility of an incorrect forecast of the extent of such increase and of the time when it may come imposes a serious business hazard against water and in favor of steam.

It has been frequently pointed out that as the nation's coal supply is depleted, the cost of coal must rise, thus increasing the cost of steam-electric power as a competitor and raising the market value of hydro-electric power accordingly. The rising price of coal is a matter of record, but it is not so generally known that the improved efficiency of boilers, engines, generators and auxiliaries has more than kept pace, so that the net cost of producing electric power from coal has steadily declined.

Factors That Influence the Cost of Power

There is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached or is even in sight. It is, therefore, a reasonable assumption that further advances in the art will continue to occur and to cut down both the fixed charges and the operating cost of steam power as a competitor of water. As bearing on the water-power situation, obviously many sites which fifteen years ago might have been developed to sell energy in successful competition with steam at its then cost could not now be so developed, and in consequence their development is no longer commercially possible.

The cost of producing power from either water or steam is a function of load. Fixed charges remain practically unchanged in both instances, whether the output in energy be large or small; but with a steam plant, increased output means increased fuel consumption, while a water plant operates either with or without load with but little variation in expense. To illustrate by a concrete example representing not unusual conditions, suppose we assume a steam plant using 2½ lb. of coal per kilowatt-hour at a price of $3 per short ton and having a plant or output factor of 35 per cent.—that is to say, an output equal to 35 per cent. of its theoretical output if every unit were loaded to capacity 24 hours each day of the year. Under these assumptions the cost of fuel per unit of installed capacity per year would be $11.50, and if the other operating and maintenance charges be assumed to fairly offset those of a water installation of equivalent size, $11.50 represents the additional fixed charges which the hydro-electric plant could carry and produce power at an equal cost. If the fixed charges (interest, taxes, insurance and amortization) total 11½ per cent., therefore, the hydro-electric investment per kilowatt capacity could exceed that of steam by $100. This is not an abnormal excess. Many hydro-electric developments exceed the cost of equivalent steam-driven systems by much greater amounts, in which cases they become commercial prospects only if either coal be more expensive per unit of output, or the plant factor be higher, or some other operating or maintenance condition be more favorable.

Inferiority of Hydro-Electric Power

As has been previously stated, hydro-electric power is inferior to steam-electric power. The reasons are elementary. Stream flow is subject to seasonal variation, and therefore to complete or partial interruption by drought in summer and by ice in winter. Floods are a menace. Long transmission lines may break from wind or sleet or the service be disarranged by lightning. The losses on such lines vary with load and are frequently responsible for annoying pressure variations. On account of these and other reasons, hydro-electric power cannot prevail against steam competition at the same or a slightly lower price. It must be materially lower.

We do not mean to imply that water power may not be a commercially practicable competitor of steam. Many successful hydro-electric installations give substantial proof to the contrary. We do wish most emphatically to combat, however, the widely held but mistaken view that any water-driven plant will produce power at lower cost than steam can, and that the margin is so large investors generally

*Excerpts from a statement prepared and presented on the special invitation of the Water Power Committee of the United States Chamber of Commerce, by the Executive Committee of Engineering Council of the United Engineering Society.

are eagerly seeking a chance to put money into hydro-electric projects. The most careful investigation, frequently demanding substantial expenditure and the keenest scrutiny by experts, is needed to discriminate between worthy and commercially impractical projects, and the difference is often so small that the imposition of even what seem to be minor burdens is sufficient to turn the scale in favor of steam and entirely prevent what might otherwise be a desirable hydro-electric development.

The second condition which vitally affects development is statutory. After ten years or more of discussion it has come to be generally agreed that our Federal laws discourage the development of a large proportion of the nation's water powers, and remedial legislation has been considered at every session of Congress for many years. The legal obstacles are quite distinct and separate from the economic facts which have been previously described and are in addition thereto.

Of the estimated 55,000,000 undeveloped water horsepower in the entire country, approximately 40,000,000 is within the boundaries of the thirteen so-called Western water-power states. In these same states the Federal Government still retains as proprietor 760,000,000 acres, or over two-thirds of the aggregate acreage of all these states taken together. In order to develop power in that section it is therefore nearly always necessary to use some part of this public domain, if not for the dam site itself, at least for flowage, for transmission right-of-way or for some other purpose. Existing law forbids such use except under permit issued by the Secretary of the Interior and revocable without cause, at any time, by himself or his successor in office.

It was once believed that revocation would only follow gross abuse well established by evidence; but the drastic action of a one-time Secretary of the Interior some years since to the contrary disabused investors of this confidence and demonstrated by a sad object lesson the insecure tenure afforded by existing law. As funds for hydro-electric development must come from private sources, the unstable tenure imposed by this condition has constituted so great a hazard of loss that the private investor has been loath to assume it. The unfortunate—almost disastrous—result has been practical stagnation in water-power development for many years.

Many available power sites not in the Western States, or not on the public domain, are on navigable streams. For each such project a special act of Congress is necessary. The difficulty of obtaining suitable rights by this means has been found so very great as largely to discourage, even if not entirely to prevent, the developments affected.

It should be pointed out that a hydro-electric enterprise being once successfully established, it is alike to the interest of the owners of the Government and of the public that it should continue indefinitely without interruption. There is no economic reason to be served by a cessation, and the only reasons for providing a legal means of recapturing the installation and the water rights are to preserve an additional measure of Government control against possible abuse by the permittee, and to provide for a contingency which might make it desirable that the Government would want to use the power for some other purpose.

In nearly all cases steam plants are necessary to supplement hydro-electric power at periods of low water and in case of interruption, as well as, in some instances, to provide increased capacity. In fact, modern practice is rapidly approaching that of providing steam capacity equal to 100 per cent. of hydro-electric for the purposes stated. In any event the growth of the enterprise over a term of years will be continuous and progressive. There will never come a time when it may be said to have been completed and subject to no further expansion. This continuing growth makes burdensome and usually abortive any attempt to amortize the investment, while the investment in other water powers or in steam plants or both, interconnected with, and generally dependent for their economic operation on, the original development renders the right to recapture that development very onerous and one which constitutes a serious impediment to the free and full development of an enterprise which is otherwise most desirable from all viewpoints.

With respect to power sites on the public domain and on navigable streams, the Government is in the position of seeking to have its resources developed without assuming any business hazard and without contributing either capital or credit. It would be unfortunate, in the light of past experience, if any new laws which may be enacted should put the Government in the position of bargaining with capital and of offering just sufficient incentive not to induce capital to undertake the developments desired, thereby, while apparently providing a remedy, in reality insuring a continuance of the present undesirable condition.

It is our belief that the benefits afforded the communities served by cheap power, and to the nation by the conservation of coal resulting from the substitution of a self-renewing for a nonrenewable natural resource are far more valuable than is the exact solution of the question of restricting the returns to capital to their irreducible minimum. The present emergency due to the progress of the war has forcibly illustrated the importance of having developed the greatest possible number of water powers as a source of industrial power supply. As it consumes no fuel, the substitution of water for steam power would release to other uses all the extensive railroad and water facilities now engaged in transporting coal. It would similarly release a corresponding volume of labor now occupied in mining this coal and in operating such transportation agencies as well as the boiler-room forces of the steam-power plants themselves.

—By Gibbs in Baltimore *Sun*

The Only Other Fuel Shortage That Could Please Him More.—By Webster
ANOTHER GLORIOUS VICTORY!
THE HADES DAILY GROWL
FUEL SHORTAGE IN HADES
BRIMSTONE LAKE FREEZES OVER THE FIRST TIME IN HISTORY
FUEL ADMINISTRATOR ORDERS ALL INSTITUTIONS OF TORTURE BLOTTED OUT
INTENSE COMFORT THROUGHOUT INFERNAL REGIONS

—By Webster in N. Y. *Globe*

Looked Worse Than It Tasted.
I THOUGHT THAT STUFF WAS GOING TO POISON ME, DOC, BUT IT DIDN'T. I FEEL GREAT!
FUEL-ORDER NO-MONDAY TONIC
THE CHARITY'S BUSINESS

—By Gibbs in Baltimore *Sun*

What We Do and Don't Know About Heating*

By PROF. JOHN R. ALLEN

THERE are many things we know about heating and I will try to enumerate the principal ones; there are many things we don't know about heating, but *can* know if we would take the time and the money necessary to investigate. There are also many things that we will never know, because the problem involves too many variables which can never be solved.

Let us start first by considering the laws of heat. Most of the useful experiments that can be immediately applied to heating were first made by Peclet in 1840 to 1850. Peclet's work was translated into English by Box about 1880 and is given in Box's "Treatise on Heat." Almost every author since Box's time has quoted Box and given Box's constants for radiation, conduction and convection. Some authors have given him credit, but most authors seem to have forgotten the source of their information.

In recent years very little fundamental work has been done by physicists upon heat and its application. The modern physicist is wedded to electricity, and he can tell you the electrical resistance of iridium and titanium and all the metals that are never used for electrical conduction, but he cannot tell you the heat resistance of a brick or a piece of stone, or a piece of concrete. There is a real reason for this. Heat is extremely difficult to experiment with accurately and electricity is the easiest of all the fields of research. If electricity is in its infancy, as is often said, heating is in embryo and unborn. We know a thousand things about electricity to one that we know about heat.

Has anyone ever looked up the various authors to find the constants for radiation, conduction and convection? If so, he would have found results varying as much as 100 per cent. There is an opportunity for some physicist to make himself undyingly famous by establishing beyond controversy some of these much-used constants. It is this lack of fundamental knowledge that has hampered and is still hampering the heating engineer in dealing with the heat problems connected with his business. This lack of fundamental knowledge has affected all our experimental work. We make small experiments through a very narrow range of observation on very special devices, and these experiments would be absolutely unnecessary had we the fundamental principles underlying these devices.

Of the fundamental laws we probably know a little about conduction, still less about convection and very little about radiation. We find the statement made in physics that a dull-black surface radiates the most heat. In my own experiments upon cast-iron radiators I found that there was practically no difference in heat transmission between dull-black and pure-white polished surfaces. In fact the pure-white polished surface gave off about 3 per cent. more heat than the dull-black. These are facts that my physicist friends have never been able to explain.

Heat Loss From Buildings

Consider heat losses from buildings. For years we guessed at them by some rule-of-thumb. These rules were usually proposed by someone supposed to know more about heat than anyone else and were usually very dangerous to apply throughout a wide range of conditions.

We have followed the German, the theory of which is generally considered to be at least approximately correct, but these formulas require certain practical constants for heat transmission. The heat laboratory at Charlottenburg has determined many of these constants for German forms of building construction, but very little work has been done in this country. Some years ago I started to check up the German constant for glass, which of course is the most fundamental constant that we have. I found that for dry glass with no rain or wind the constant $K = 0.64$; for rain and no wind, $K = 1.248$; for wind and no rain, $K = 1.05$; for rain and wind, $K = 1.485$. The generally accepted constant by authors as determined by the German government is 1.3 and for fifteen years we have accepted this constant. It is entirely possible to have the glass surface wet even in zero weather and the constant is manifestly too small. Personally I am now using $K = 1.25$ as the glass constant. This only goes to show that some of our fundamental facts are wrong and need a careful checking up.

When it comes to the constant K for cement, hollow tile, metal lath and similar construction, practically all the constants we have are based upon computation—they are only approximate. They may be right; they are probably wrong or largely in error, and we have no experimental work to guide us. We need in this country a vast amount of experimental research so as to place these fundamental constants of the heating business on a well-established foundation.

Infiltration and Radiation

One of the important factors in determining the heat loss from a building is the amount of air that leaks in around the cracks and crevices. One of the first assumptions with respect to infiltration was made by Carpenter, in which he assumed that the air in a room was changed once per hour due to infusion of air from outside or infiltration. In the average room this is approximately true. On the other hand, there is absolutely no reason why the cubic contents should have anything to do with infiltration, as infiltration occurs largely around the windows and window frames, and it should be based on wall and window conditions and not upon cubic contents. Recent experiments in New York show that, particularly in metal sash, infiltration should be based upon the perimeter of the sash.

Of course, there is one factor in this that we will never know, as no one can foresee how tight or how loose the contractor is going to construct the building. The equation of the contractor has never been determined, and considering the number of variables entering into the problem, it never will be determined. Such phases of our computations will always have to be covered by adding a certain percentage which might well be called the "factor of ignorance."

We have much more explicit information in regard to radiation than in regard to heat loss from buildings. We know that a two-column 38-in. radiator will give a value of K of about 1.65 B.t.u. with 1 lb. steam pressure and a room temperature of 70 deg. We know that this constant K increases as the difference between the temperature outside the radiator and the temperature inside the radiator increases. The approximate formula is:

$$K = 1.445 + 0.001437\ (T_1 - T_2)$$

where T_1 = the temperature of the steam and T_2 = the temperature of the room.

We know something about the painting of radiators. If a radiator is painted with any kind of flake metal pigment, such as aluminum, gold or bronze, its efficiency is reduced approximately 25 per cent. If it is painted right over the aluminum with an enamel, the heat transmission is the same as the bare iron. I have made these experiments with 14 coats of paint on the radiator and the effect of the last coat was practically the same as that of the first coat.

This shows that the heat transmission of the radiator depends upon the ability of the surface to dispose of the heat and not upon the conductivity of the material of which the radiator is composed. That is, under the conditions existing in a radiator, the heat is transmitted much more rapidly through the metal of the radiator than the surface of the radiator can dissipate the heat. It is possible that we may find some coating which can be placed upon a radiator that will increase its conductivity beyond that of the bare iron. I do not know that any attempts have ever been made to do this, but it is one possible means of increasing radiator efficiency.

A radiator gives off heat in two ways—by radiation and by convection. For many years I have tried to find out what proportion of the heat is given off by radiation and what proportion by convection. Approximately it is "50-50," but I have never been able to make a satisfactory determination. This is impossible as undoubtedly some of the radiant heat from the radiator passes directly out through the wall and window surface without having any effect, and we may find it desirable to so arrange our radiators that all heat given off by them is given off by convection. We should have more fundamental knowledge on this subject.

Take the indirect radiation, and by indirect radiation I mean that not only through which air circulates by natural circulation, but through which air circulates by means of a

*A paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York City, Jan. 23, 1918.

fan or of fan coils. We know that in this type of radiator all the heat from the radiator is given off by convection and in convection the form of the surface plays a very important part in its effectiveness. We also know, and recent experiments prove, that effectiveness of its surface is practically independent of the material of which the surface is composed. Copper, cast iron and wrought iron give practically the same effect.

The condensation from surfaces of this kind depends upon the air resistance of the radiator, provided the radiator is properly designed. That all depends upon the temperature of the surface and the temperature of the air. Since the condensation depends upon the air resistance of the radiator, in radiators of this class low resistance is not wanted because in order to get the condensation, it will be necessary to put in a number of radiators. Some engineers have specified widely spaced fan coils of low resistance and then put in a bank of coils in order to obtain condensation. This is simply wasting surface, as the same heating effect could be produced with closely-spaced coils and a much smaller number of them.

Determining Pipe Sizes

In this country we probably give less consideration to pipe sizes than in any other engineering country. The sins committed by the average contractor in the matter of pipe sizes are legion. When we get down to the economical use of pipe there is just one way to determine the sizes and that is to determine the resistance of each piece of pipe. We design good fan piping systems for air by resistance and yet we design our steam-piping sizes on a heating job by guesswork and experience—these terms are sometimes synonymous.

Some years ago, when I had some time on my hands and a heating plant was to be designed, I designed a real piping job and figured the pipe resistance to each radiator, and it is the most satisfactory job of heating that I ever installed. The average engineer, however, is too lazy to go to the trouble of doing this, and I am just as guilty as the rest.

To take pipe sizes out of a table and have them determined by the square feet of radiation is no basis of reason on a large job. It is quite possible that close to the boiler you can put 150 sq.ft. of radiation on a 1¼-in. riser, while at a remote point a 1¼-in. riser might carry only 60 sq.ft. A tremendous amount of pipe is wasted in the heating business by using excessive sizes. To design a system of this kind requires great accuracy but gives economical results.

The modern piping system in a steam-heating installation always reminds me of a small pumping station I once inspected. The board of directors had purchased a pump with a 2-in. discharge, and they instructed the engineer to run the 2-in. pipe from the pump a distance of three-quarters of a mile. When I came to examine the pipe I found that the pump was working against a static head of 70 lb. and friction head of 100 lb., and that in place of a 2-in. pipe they should have had a 6-in. pipe when the calculations were based on friction.

In the heating business, however, we more often make the mistake of using pipe too large rather than pipe too small, particularly in the smaller installations. In hot-water piping with forced circulation it is absolutely necessary to work from friction, if uniform circulation and no short-circuiting is expected.

Pipe Coverings

We have some very good information upon the subject of pipe coverings above ground. We are just acquiring a little information in regard to pipe coverings below ground. I have been making some experiments on pipes buried in the ground without any covering. The surprising thing in these experiments is the great distance that heat is transmitted through the ground. It is possible to detect a steam pipe under ground twenty feet away.

We also find that the condensation below ground is less than the condensation in the air. Our latest experiments show that there is less condensation with the steam passing through the pipe at a good velocity than with the steam in a quiescent state in the pipe. Of course, the deeper the pipe is buried in the ground the less is the heat transmission, and if we were to bury a pipe to a sufficient depth it would be unnecessary to have any covering at all—the ground would serve as its own heat insulator, so that the deeper we run heating ducts and heating pipes the less we need insulation. This fact is often lost sight of. Exact data in regard to these facts are not available, but as a number of experiments are being carried on we undoubtedly will soon be able to make some exact statements.

Every heating engineer seems to have an ambition to invent some new heating device that everyone will have to use and that incidentally will give him an opportunity to make some money. There have been placed upon the market and advertised, thousands and thousands of heating devices. Some of them are very good, some do no harm when placed upon the heating plant, and some are positively detrimental. Some are very good when properly applied and are useless under other conditions.

Some years ago I installed a heating plant in a residence, and the plant is almost identical with a certain patented system of heating now on the market. The only difference between my system and the patented one is that I left off all the patented articles and my system, I think, works a little better than similar near-by systems that used the patented articles.

We must always remember as engineers that the best design is always the simplest. There is a tendency among all engineers in the heating business to complicate their systems—to use too many unnecessary devices. This is largely due to the fact that these devices have been urged upon them by salesmen who must secure business. Many of these devices are very meritorious, but the attempt is to give them universal application when they should only be applied in specific cases.

The purpose of these remarks has been to emphasize:

1. The necessity of bringing to the attention of physicists and scientific men the fact that we need more knowledge of the science of heat and heat transmission. As we get more and more exact knowledge, this knowledge should be used by the engineer so as to leave less to experience and guesswork and more to actual figures. It will never be possible, however, in heating work to entirely eliminate the factor of judgment. So many variables enter into the problem, such as the conditions of building construction and the materials used, that we will always have to make our figures only the basis for our judgment.

2. To call the attention of engineers to the tendency to overload the plants with unnecessary devices and to urge the greatest simplicity in construction and the economical use of materials. The present high prices of piping and materials should lead us to consider every possible means of conserving these materials.

Cost Plus a Fair (?) Profit

Fuel-oil prices are discussed in a special bulletin issued Jan. 27 by the Federal Trade Commission, showing wide variation between the cost of oil plus refining and the sale price, particularly in the East and Middle West.

The figures are based on August reports of the refiners. The commission notes that published quotations show that prices now are from 70 to 104 per cent. higher than they were in June. Following are the August figures in cents for "representative cost," refining charge and sale price at district centers:

	Cost Crude	Refining	Cost Refined	Selling Price	Percentage Profit
New Jersey and Eastern Territory (Pittsburgh)	$3.34	$0.94	$4.28	$8.00	87
Indiana and North Mississippi Valley (Chicago)	2.04	.47	2.51	5.75	129
Oklahoma (Tulsa)	1.85	.58	2.43	3.60	48
Gulf Coast (Ft. Worth)	2.14	.33	2.47	4.00	62
California Coast (San Francisco)	1.96	.29	2.25	3.45	53

The selling prices given were those at the district centers named in the first column.

Appointment of Ordnance Draftsmen

The Bureau of Ordnance, Navy Department, is in need of competent draftsmen. Men who are graduates in mechanical engineering from a technical school or college of recognized standing and have had some drafting-room experience, or men who are competent designers of heavy machinery, engines or shop tools, and have had a number of years' drafting-room experience, are eligible for these positions. The pay ranges from $4 to $6.88 a day, depending upon the qualifications of the draftsman.

There are now a number of vacancies in the rating of draftsman at the Washington Navy Yard. Additional information may be had by addressing the Commandant and Superintendent, Naval Gun Factory, Navy Yard, Washington, D. C.

Labor in Its Relation to National Efficiency

Until within a month the most discouraging fact to those looking on in Washington was the lack of any indication of broad consideration of the labor problem. The President's speech before the American Federation of Labor put up no constructive policy. It was a patriotic appeal. The Department of Labor was dealing with industrial disputes as they arose, but there was no expression of fundamentals. The direct parties to the controversy—employers and employees—were pulling apart instead of being drawn together. Apparently, as far as official Washington was concerned, we were to be allowed to come to an *impasse* without any effort on the part of the Government to compromise the difficulties.

Within two weeks there has been a most remarkable and a most welcome change. Today machinery is in motion which will bring the contending interests together on a broad basis. Light has broken. Hope has succeeded the discouragement of last month.

The first official recognition of the need for a broad consideration of the problem was the appointment of an Advisory Council to the Secretary of Labor. This appointment —far more important, broadly speaking, than many of the problems that have occupied front-page space—was hardly noticed in the public prints. Yet that council is expected to determine the policy that shall keep labor and capital working together during the war. More than this, if their work is far-seeing—as the constitution of the council gives warrant for expecting—it should have a tremendous, if not the determining, influence on the socio-economic conditions under which we shall live after the war. To industry, therefore—yes, and to labor, to the country at large—the establishment of the council is easily the most important event since the beginning of the war.

Lest this estimate of the importance of the council be considered extravagant, it will be well to set down here the work outlined for it. It will consider the establishment, in the Department of Labor, of agencies to perform the following functions:

1. A means of furnishing an adequate and stable supply of labor to war industries. This would embrace: (a) a satisfactory system of labor exchanges; (b) a satisfactory method and administration of training of workers; (c) an agency for determining priorities of labor demand; (d) agencies for dilution of skilled labor as and when needed.

2. Machinery that will provide for the immediate and equitable adjustment of disputes in accordance with the principles to be agreed upon between labor and capital and without stoppage of work. Such machinery would deal with demands concerning wages, hours, shop conditions, etc.

3. Machinery for safeguarding conditions of labor in the production of war essentials—this to include industrial hygiene, safety, woman and child labor, etc.

4. Machinery for safeguarding conditions of living, including housing, transportation, etc.

5. Fact-gathering body to assemble and present data collected through various existing Governmental agencies or by independent research to furnish the information necessary for effective executive action.

6. Publicity and educational division, which has the function of developing sound public sentiment, securing an exchange of information between departments of labor administration and promotion in industrial plants of local machinery helpful in carrying out the national labor program.

The first four divisions cover matters familiar to all manufacturers, contractors and engineers. Subdivisions (b), (c) and (d) of function (1) represent activities made necessary by the war. The true significance of the establishment of the body is appreciated when attention is directed to the sixth division, and when we recall the activities of the labor division of the British Ministry of Munitions and the influence that its work, of the same broad scope, has had on industrial England. What can one not read into "the function of developing sound public sentiment" and "promotion in industrial plants of local machinery helpful in carrying out the national labor program"? such program obviously being comprehended in the determination of the first four divisions of the program. One may expect that the "developing of a sound public sentiment" will necessitate the statement of the fundamentals for industrial and labor prosperity—a difficult task, but one the performance of which would be of the greatest value.

If further evidence is needed as to the possible influence of the council, it is furnished by its action last week in recommending to the Secretary of Labor (1) the organization of a board which will formulate an arrangement for ending strikes and (2) the centralization in his department of the industrial service divisions of the various branches of the war machine. Both plans have been approved by the secretary. The first of them is absolutely essential if coöperation is to replace strife.

The personnel of the council, as has been said, gives warrant for expecting broad-gaged results. It is headed by John Lind, former governor of Minnesota and envoy to Mexico, representing the public; Waddill Catchings, president of the Sloss-Sheffield Steel and Iron Co. and of the Platt Iron Works; and A. A. Landon, general manager of the American Radiator Co., representing the employers. Labor's members are John B. Lennon, treasurer of the American Federation of Labor, and John J. Casey, former member of Congress. Dr. L. C. Marshall, of the University of Chicago, is the economist member, and Agnes Nestor, of Chicago, represents women.

The council's duty is not merely to formulate a program, but to recommend the machinery for putting it into effect. That it believes in action is shown by its two public acts within ten days after its organization. Industrial leaders will be impressed by that evidence of virility and will follow closely the further activities of the body.—*E. J. Mehren, in Engineering News-Record.*

Work of the Labor Divisions of War Administration Co-ordinated

Upon the recommendation of the Advisory Council created to report on the handling of industrial relations growing out of the war, the Secretary of Labor has arranged for the coördination of the industrial service (labor) activities being developed in the various purchasing and supervisory offices of the war administration. Simultaneously, a number of new bureaus have been established and will assume the coördinating functions.

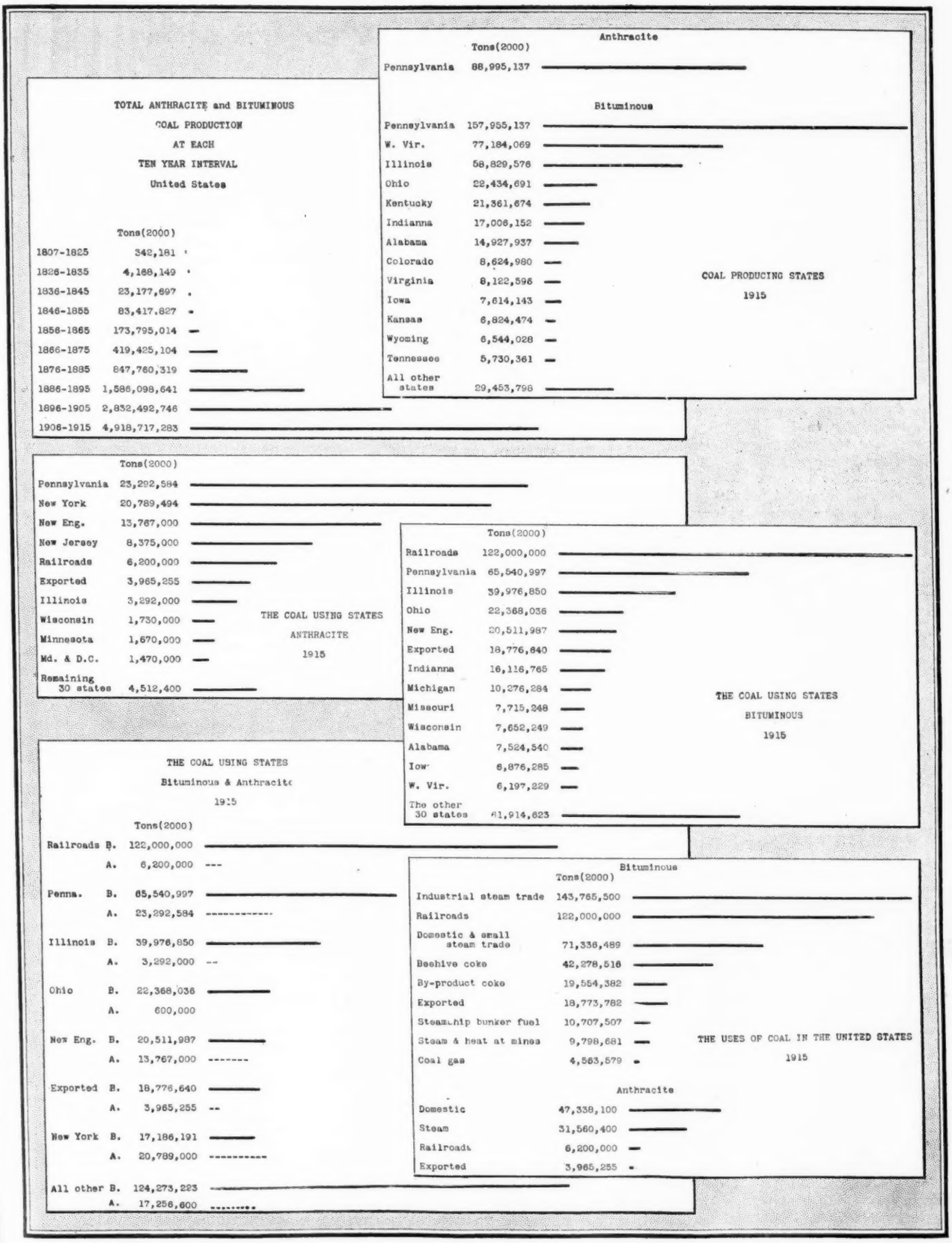
A well-developed industrial service division is in operation in the Ordnance Department, and similar organizations are being worked up in the other purchasing and supervisory branches of the War Department as well as in the Navy Department and the Shipping Board. These bodies are all developing plans for accomplishing similar results in their own given departments. In some cases they might, if not coördinated, work to cross purposes, and in any of their activities exchange of views on methods is desirable. The necessary machinery for getting together is now provided by the action of the Secretary of Labor.

The following new bureaus are established to effect the desired coördination: (1) Adjustment Bureau, to deal with disputes; (2) Condition of Labor Bureau, to administer conditions of labor within business plants, such as safety, sanitation, etc.; (3) information and Education Bureau, to promote sound sentiment and to provide appropriate local machinery and policies in individual plants; (4) Women in Industry Bureau, to correlate the activities of various agencies dealing with this matter; (5) Training and Dilution Bureau; (6) Bureau of Housing and Transportation of Workers; (7) Bureau of Personnel (which may possibly be fused with the Information and Education Bureau).

The present United States Employment Service will act as the coördinating bureau on the procurement of labor.

In a theater, hall or other densely filled room, the body heat given off by the occupants must be considered. This averages 425 B.t.u. per hour per person. After the building is once warm, thoroughly heated and the performance has started, it is more a problem of cooling than of heating, and it is the ventilation which is of prime importance.—*B. F. Sturtevant Engineering Series.*

Production and Uses of Coal in the United States



The above tables, with graphical representations of coal production in the United States and of consumption for the year 1915, were presented by Prof. L. P. Breckenridge at the recent meeting of the American Society of Heating and Ventilating Engineers.

The total production shown for the ten-year period 1906-15 would give an average annual production of 491,871,728 short tons. For 1916 the total production in the United States was 590,098,175 short tons, and for 1917 it was increased to 633,401,789 short tons.

Points in Steam-Boiler Management*

BY C. E. STROMEYER†

Some points relating to the safe and economical operation of steam boilers, obtained from the experience of an association which has been engaged for over fifty years in the prevention of boiler explosions by scientific inspection.

AN EFFECT of the war conditions is the scarcity of labor and its replacement by substitutes. As a rule boiler attendants of former days, if engaged from outside, will have had varied boiler experiences, or if they were advanced from the position of laborers, they will have been selected on account of their reliable disposition and will have received some training. It is a mistake to imagine that boiler attendants should think that they are competent to judge of the safety of boilers. Their first and foremost qualification should be reliability. In fact, the little knowledge which can be imparted to them may be or, rather, often has been a dangerous thing. A fireman who has been taught to believe that it is dangerous, especially to himself, to overload the safety valve or to allow the water level to sink out of sight is safer than a man who has heard that a boiler is worked at a factor of safety of four or five and overloads the safety valve or who knows that the gage-glass bottom is 3 in. or 5 in. above the furnace crown and, once too often, allows the water level to fall out of sight.

There are, of course, many good men among the substitutes and many willing men who wish to do their best. They show their willingness by working hard, but a busy stoker is rarely a good one. A stoker's limited duty is to shovel coal on the fire, watch the pressure gage and water level, and manipulate the feed valve. A man who is new to his job is probably at first not impressed with the importance of these matters. Not until he discovers that the works actually engage an inspector to carefully examine the inside of the boiler, to adjust the safety and low-water alarm valves, and to verify the pressure and water gages, does he become impressed with the importance of these matters and of his own duties.

Substitutes Frequently Reduce Efficiency

Another effect of having to employ substitutes in place of well-tried stokers is that the efficiency as well as the output of boilers is very frequently reduced. This is particularly annoying at the present time, when coal is both scarce and dear and increasing demands are made on boilers. Take the case of a boiler that used to be fired with good coal by an expert fireman. Possibly the duty of such a boiler might have been increased 10 per cent. without a reduction of efficiency. If, however, the demand for steam has increased 10 per cent., if the quality of the coal has been reduced, and if an inexperienced stoker has been engaged, the probability is that he will not be able to maintain steam, he will rake and slice his fires and reduce the efficiency by perhaps 10 per cent., and the boiler, which is probably unable to increase its consumption by 20 per cent., wastes coal and reduces its steam production.

It seems desirable to discuss the suggestion that managers should set aside a day or two to the study of the firing problem, and devote themselves to the teaching, or rather guiding, of the newly appointed fireman. If, as may easily be the case, especially with the present high coal prices, such a procedure should result in a saving, the time and trouble will have been well spent.

Seeing that the best teachers are said to be those who are learning while teaching, the owner or his manager who watches the stoking operation need not imagine that his is a case of the blind leading the blind. The leading principles are exceedingly simple and are based on what is transparently obvious, that the maximum quantity of steam is produced from a ton of coal if the heat losses are reduced to a minimum.

The man who may be watching the fireman will soon discover that the more quickly the firing is done the more easily can steam be maintained, but only if the firing is properly done. Suppose that the coal is thrown on the grate anyhow; then, as there is less resistance to the passage of air at the thin parts than at the thick ones, the latter hardly burn away at all, while the former burn themselves first into pockets and then into holes, and long before the next firing is done there will be a rush of cold air through these holes. This unfavorable condition has, of course, to be remedied by raking, but that operation introduces cold air and results in a diminished steam production and a reduced efficiency.

It would, however, be wrong to forbid the raking of the fires or the opening of the doors. Some coals must be broken up, and some coals, because they produce smoke, must be supplied with air through the doors. This latter air supply has to be regulated by studying the smoke discharged from the chimney. If it is black or dark, then the air supply through the fire-door is insufficient; if there is no smoke, then there is an excess of air either through the door or through holes in the bed of fuel or through the bed of fuel if this is too thin.

How To Fire Different Qualities of Coal

As some of the preceding remarks apply only to smoke-producing coal, a few words on the firing of different qualities will be needed. Roughly speaking, coals can be divided into caking and noncaking coals. The latter break up while burning, and if disturbed by raking, they fall through the grates and the result is much waste. Coal of this class should therefore be thrown evenly on the grate and should not be disturbed. Considerable manual skill and a good eye are required to do this work properly, and inexperienced firemen will have to use the rake.

Caking coal, on the other hand, must be broken up after it has become heated and stuck together. Caking coal produces smoke, and that has to be avoided. The general practice with this coal is therefore to throw it on the front end of the grate, nearly choking the fire-door hole, which is kept open during the time that the mass of coal is warming up and producing smoke and combustible gases. Then this mass of coal is broken up with a rake and shoved back, the fire-door being entirely or partly closed some time after. Another method, called side firing, is equally effective in preventing smoke. The firing interval of, say, fifteen minutes is divided into two short ones of about seven minutes, and during the one opening of the door the fuel is thrown only on the one side of the grate, and during the next on the other side. The smoke which is produced on the newly charged side is consumed as it passes to the other side. If this firing were done with the help of long troughs filled with coal, in the same way that horizontal gas retorts are charged, the periods during which the fire-doors are open could be very much curtailed and the efficiency of the furnaces improved.

Inspection and Cleaning of Flues Necessary

Bad results are, however, not always due to the fireman; in many cases the inspection and cleaning of flues is not properly carried out. In a certain factory the power requirements had increased somewhat, and on account of bad coal and poor firemen the steam production sank lower and lower and the coal consumption rose higher and higher. On the advice of an outsider, which advice seemed reasonable under the existing conditions, a sixth boiler was added to the five overworked ones. Then the trouble grew

*Excerpts from "Memorandum by Chief Engineer" of the Manchester Steam Users' Association.

†Chief engineer, Manchester Steam Users' Association.

worse; even more coal was burnt, and less steam was produced. Several people were asked to give advice, and we too were appealed to. On examining the various dimensions it was found that the flue area was only suitable for three boilers, and as alterations could easily be made, we recommended the building of a larger flue. It was also discovered that there was a solid layer of flue dust, which must have been damp occasionally, of two feet in thickness. The factory can now be worked with the greatest ease with five boilers, and the saving of coal is probably well over $5000 per annum.

A source of recurring trouble is the disturbance of the brickwork of the flues and outer walls. It is an almost daily occurrence that our inspectors draw attention to these and similar defects in the flues and thus help to maintain the efficiency. That these disturbances should occur is but natural, for the difference in length of a boiler when cold and when hot is about half an inch, and as it is a heavy weight, it is sure to pull the brickwork about. These expansions and contractions also affect the outer walls, which crack and admit air, and this unnecessary air wastes much heat. As these cracks may occur the day after an inspection, it is desirable to look for them and have them plastered up. Searching along the walls with lamp or candle flames is not an efficient method. A simpler plan is to have the boiler walls, especially the front and the blowoff pit, whitewashed as frequently as may be found necessary. If any cracks occur, the inrushing air, laden with coal dust, will blacken the cracks, and these can then be plastered up and whitewashed.

In continuation of my analysis of the Board of Trade reports on boiler explosions, those accidents which were due to wasting of shell plates have now been taken in hand. The analysis embraces 75 reports. The general conclusion to be drawn from these practical cases, and it is an important one, is that when wrought iron plates are very materially reduced in thickness by corrosion, their tenacity is also reduced to about one-third of its original value.

In plotting these 75 explosions against the years in which they occurred, it appears as if the prospect of the early passing of the Factory and Workshops Act, with its compulsory inspection clauses, had frightened many careless owners into having their neglected boilers examined. At any rate, whereas before 1900 there were on an average three explosions per annum due to shell wasting, from that date the average number was reduced to one.

Men Wanted for Shipyard Work

The Department of Labor is seeking to enroll 250,000 men for work in shipyards. A nation-wide campaign began Jan. 28 with an appeal to all men possessing any skill in any of the trades necessary to the building of ships to enroll as a reserve supply of labor sufficient to meet present and future needs of the shipyards. Some of the men enrolled will be called upon at once, others as they are needed. Men who enroll themselves will not sacrifice independence of action, and are advised to remain at their present jobs until notified that places in shipyards are open to them. The "four-minute men" will conduct a speaking campaign in every state.

Following is the quota for each state: Maine, 2972; New Hampshire, 1698; Vermont, 1390; Massachusetts, 14,321; Rhode Island, 2355; Connecticut, 4786; New York, 39,526; New Jersey, 11,348; Pennsylvania, 32,771; Ohio, 19,802; Indiana, 10,847; Illinois, 23,662; Michigan, 11,734; Wisconsin, 9611; Minnesota, 8762; Iowa, 8531; Missouri, 11,812; North Dakota, 2548; South Dakota, 2393; Nebraska, 4400; Kansas, 6330; Delaware, 811; Maryland, 5250; Virginia, 8453; West Virginia, 5327; North Carolina, 9264; South Carolina, 6253; Georgia, 11,001; Florida, 3435; Kentucky, 8260; Tennessee, 7952; Alabama, 8994; Mississippi, 7488; Arkansas, 6022; Louisiana, 7064; Oklahoma, 8492; Texas, 17,023; Montana, 1583; Idaho, 1621; Wyoming, 618; Colorado, 3320; New Mexico, 1428; Arizona, 888; Utah, 1660; Nevada, 386; Washington, 5906; Oregon, 3204; California, 11,310.

The American Engineer*

The American engineer is that citizen of the United States who is qualified by training and practice to join with his coworkers to direct organizations and harness natural resources which will crush the greatest menace to Christianity and make the world safe for democracy.

He is the man who will after this war solve the great international problems of making all countries safe and sanitary for their peoples.

He is the man who has for his foundation a broad engineering education that has prepared him to use the natural elements which he has discovered and developed through experiment until today the Atlantic and the Pacific are speedways; the air is a highway free from dust and the shortest distance between two points for travel, and a line for conversation by telegraph and telephone; the swamps are the best fields for grain; and the hills and mountains are producing untold wealth.

He is the man who recommends the expenditures of millions by his government or by the business men of the country. All industry, either in war or peace, depends upon the engineer for production and operation. Our profession is extremely fortunate to have the opportunity to step in and be the deciding factor in the war which will mean most to civilization for all ages.

The American engineer is the man of the hour.

Would Utilize Peat

Governor McCall of Massachusetts has sent a message to the legislature, saying in part: "I recommend that you make an investigation of uses of peat, the near-by deposits, the methods of its utilization in producing heat and power, and in other ways with a view to enacting such legislation relating to it as your investigation may show to be for the public interest. Peat has long been used as fuel in different countries, and I am informed that at present it is utilized in Germany in the production of heat and power, in munitions of war and even in clothing, through use of its fiber. I am advised that large deposits exist in New England, and that even under existing methods of preparation much of it may be made available for power and heat before the coming of another winter.

"Its large content of ammonia would tend to relieve scarcity of that article, much needed now in the making of munitions and invaluable at all times for use in agriculture. We are largely dependent on coal for heating our homes and keeping our industries in motion. If we have on hand in great quantities a substance which may make us less dependent upon coal, it is our obvious duty to take steps for its development. I believe the subject well worth immediate investigation by you either through a regular or special committee or in some other way, and that a moderate appropriation be granted to make the investigation effective."—*Boston News Bureau.*

Ecuador and Peru Favor American Electrical Goods

America's opportunity of increasing its sales of electrical goods in Ecuador and Peru during the absence of German competition is pointed out in a report made public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. Before the war this trade was divided between Germany and the United States, the advantage being with the American manufacturer. The Government's report is concerned with the market as it exists today and the opportunities it offers for the future.

Copies of "Electrical Goods in Ecuador and Peru," Special Agents Series No. 154, can be purchased at the nominal price of 10c. from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or coöperative offices of the Bureau of Foreign and Domestic Commerce.

*From address given before the Savannah Chapter of the American Association of Engineers, Saturday, Jan. 26, by A. H. Krom, general secretary, American Association of Engineers.

Firing Bituminous Coal in Heating Boilers

Technical Paper 180, "Firing Bituminous Coals in Large House-Heating Boilers," by S. B. Flagg, Bureau of Mines, tells how to burn bituminous coals economically in these large house-heating boilers.

In burning bituminous coals in large house-heating boilers the fuel bed should not be seriously disturbed until the coal has become well coked; that is, until the gassy part of the coal has been largely driven off.

Both caking and noncaking types of coal may be used satisfactorily in boilers of this type if properly handled.

The presence of a moderate proportion of screenings mixed with the lump coal causes the fresh charge of coal to heat more gradually and the emission of smoke is kept down more easily. Therefore such a proportion of screenings is an advantage.

Increasing the proportion of screenings in the coal necessitates the use of a stronger draft to carry the same load. Smaller firing charges must also be used and more frequent attention given. The tendency of caking coals to cake is increased and this also means that the fire must have more frequent attention.

One large charge of coal fired by the spreading method will result in a longer emission of dense smoke than the total emission of such smoke from two charges of half the size fired some time apart and by the alternate method.

With some coals moderate charges fired by the alternate method necessitate less frequent attention to the heater than larger charges fired by the spreading method. Caking coals having a considerable proportion of fine coal or screenings are usually among these. Conversely, a fire will usually require more frequent attention when a lumpy caking coal free from screenings or a noncaking coal is fired in moderate charges by the alternate method.

The number of tests made was not large enough to justify conclusions regarding the relative efficiency with which a coal may be burned by the two methods of firing, but the author believes that in actual service over considerable periods better results will be obtained by the alternate method.

Frequency of cleaning the fires will be determined by the character of the coal and the rate at which it is burned, but with most coals the fires should be cleaned only once or twice in 24 hours in ordinary weather.

If the alternate method of firing is employed, the cleaning should be done just before firing the fresh charge, and only one-half of the grate cleaned at a time. Then little or no smoke will result from the cleaning, because the side of the fire on which there is uncoked coal is not disturbed.

All three of the coals fired by the alternate method in the tests described were burned at rates corresponding to the heating conditions during the most of the winter, with scarcely any manipulation of the fuel bed except the cleaning of the fires and an occasional leveling just before firing.

The average fireman is apt to poke and slice the fire much more than is necessary. If a caking coal is used and the caked fuel must be broken up before it is well coked, slice the fire by running a straight bar under the fuel bed and raising it slightly so as to crack the caked mass. Do not stir the bed upside down by raising the bar through the fuel bed, nor break the bed with a bar from the top.

If the fuel bed is covered with a charge of fresh fuel in a layer more than 5 in. thick, the new charge, unless it is very free from slack, is likely to have a smothering effect. Then the output of the boiler will be correspondingly decreased and, especially if the spreading method of firing is employed, the mass of fresh coal will usually have to be broken once or twice before the fire will pick up. Consequently, the maximum firing charge should be not much thicker than five inches and for caking coal containing considerable slack it should not be more than four inches thick. Of course, when a fire is to be kept banked, heavier charges may be used.

Do not fire large lumps of coal. Break all lumps into pieces no larger than fist size.

Large house-heating boilers do not require an intense draft to meet any reasonable demands for heat if the fuel bed is kept in proper condition, but the draft must be properly controlled.

The damper regulator should work freely with changes in steam pressure and should close the swinging damper in the ashpit door before it starts to open the check damper in the smoke pipe.

The doors on the front of the boiler should fit snugly in their seats; special care should be taken to prevent any material wedging between the doors and the front and thus admitting air when or where it ought to be prevented from entering.

Do not allow clinkers to accumulate in the fire or too great a quantity of ashes on the grates. Be careful, however, in shaking the grates not to shake through unburned fuel.

In ordinary or severe weather keep an active fuel bed averaging ten to twelve inches deep. In milder weather the depth of active fuel may be decreased by keeping a layer of ashes on the grate under the live coals.

Copies of this technical paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

Fuel Administration Wants Uniform Regulation

The United States Fuel Administration has advised all state fuel administrators east of the Mississippi River and also those of Minnesota and Louisiana in part as follows:

As a result of various restrictive regulations established locally by state fuel administrators in certain states, we are receiving many complaints of discrimination between different states and inequalities in the requirements of neighboring communities. Fuel Administrator Garfield has concluded that regulations in every state should in general be uniform with those promulgated by Washington. This does not absolutely prohibit additional local regulations where they are necessitated by extraordinary local emergency.

We particularly desire to secure uniform regulations for the whole country at the earliest possible date, not later than Feb. 6.

In general, we feel that the United States Fuel Administrator's order of Jan. 17 is sufficiently drastic and that further extensions should not be attempted unless absolutely required by local emergency and substantially supported by local sanction.

If you have already established additional regulations, we ask that you announce a date in the near future, after which regulations in your state will be uniform with those of Washington.

Dam's Effect on Subsurface Waters

Where a power company by erecting and maintaining a dam across a stream raises the level of the water so that flow of percolating waters from adjacent lands owned by others is obstructed, and where the impounded water of the stream percolates through the adjoining land, causing subsurface waters under such land to rise and remain so near the surface as to injure the land and the crops and improvements thereon, damages may be recovered by the landowner against the power company on the theory of unreasonable interference with his enjoyment of his property. (Florida Supreme Court, Cason vs. Florida Power Co., 76 Southern Reporter, 535.)

It is difficult to put ordinary wood screws into hard timber; the thread in the wood keeps stripping, and the head of the screw may break. It can be easily done, however, in the following way: Grind or file another screw flat on one side to the form of a half-round or shell bit to be used as a tap. A small hole is first bored into the hard timber and the tap screwed into it. It will cut a good thread, and the screw can then be easily turned into the hole if it is well coated with tallow.

New Publications

Central Stations. By Terrell Croft. Published by McGraw-Hill Book Co., New York, 1917. Cloth; 5¼ x 8 in.; 332 pages; 306 illustrations. Price, $2.

Although this book has been written, as its name would indicate, to deal with central-station practice, nevertheless the major portion of the work can be read with profit to himself by almost anyone interested in the generation, transmission and distribution of electric power. The work is divided into eighteen sections. The opening section defines the terms most commonly used to designate the different components of an electrical-energy-distribution system; then the other chapters following in order take up: Distribution loss and distribution-loss factors; maximum demand, maximum-demand meters and demand factors; diversity and diversity factors; load factor, plant factor and connected-load factor; load graphs and their significance; general principles of circuit design; calculation and design of direct-current circuits; calculation and design of alterating-current circuits; transmission and distribution of electrical energy; lightning-protection apparatus; automatic voltage regulators; switchboards and switchgear; characteristics of electric-generating stations; adaptability of steam, internal-combustion engine, and hydraulic prime movers; steam-electrical-energy generating stations; internal-combustion-engine stations, and hydro-electric stations.

The treatment of alternating-current problems usually involve more or less complicated trigonometric expressions; however, the author, in the many problems on alternating-current circuits treated in this book, keeps within the bounds of simple arithmetic, therefore he can be comprehended by the reader of only limited mathematical attainments.

As the dimensions in the book would indicate, its treatment of central-stations practice must needs be limited, and in this case is confined to the practical side of the subject; therefore, the work will meet the needs of the practical electrician and station operator rather than those of the designing engineer, and it should fill a large field of usefulness with the former class of readers.

Personals

Capt. C. W. Dyson, U. S. N., of the Bureau of Steam Engineering of the Navy Department, has been promoted to the rank of rear admiral.

Rear Admiral R. S. Griffin, U. S. N., chief of the Bureau of Steam Engineering, has been reappointed as engineer-in-chief of the navy for another term of four years.

F. E. Pratt, formerly representative of the Worthington Steam Pump Co. in Brazil, is now New York sales manager of the Steam Motors Co., Inc., with offices at 30 Church St.

E. P. Worden, formerly chief engineer of Henry R. Worthington Pump Corp., has resigned to accept the position of mechanical engineer for the Submarine Boat Corp., New York.

J. H. Pardee, president of The J. G. White Management Corporation, New York, and J. P. Ripley, engineer, have returned to New York from a general inspection of the Manila Electric Railroad and Light Co. and other interests in the Philippine Islands operated by The J. G. White Management Corporation.

Engineering Affairs

The American Society of Mechanical Engineers announces the following sections meeting: Buffalo, N. Y., Feb. 26; Meriden, Conn., Feb. 14; New York City, Feb. 21; Philadelphia, Feb. 26.

New York Chapter A. A. E.—At the next meeting of the New York Chapter of the American Association of Engineers, which will be held at the Hotel McAlpin on Wednesday, Feb. 13 at 8 P.M., H. H. Bubar, of the National Aniline and Chemical Co., will speak on "The Engineer; His Present and Future."

The Trustees of the United Engineering Society, held their annual meeting Jan. 24, and elected the following officers for the ensuing year: President, Charles F. Rand, member A. I. M. E.; first vice president, Calvert Townley, member A. I. E. E.; second vice president, Robert M. Dixon, member A. S. M. E.; treasurer, Dr. Joseph Struthers, member A. I. M. E.; secretary, Alfred D. Flinn, member A. S. C. E.; chairman finance committee, J. Vipond Davies, member A. S. C. E.

The American Institute of Electrical Engineers will hold its sixth annual midwinter convention on Feb. 15 and 16, in the Engineering Societies Building, New York City. The convention will include four technical sessions, which will take place on Friday morning, afternoon and evening, and Saturday morning. A strictly informal dinner will be held at the Cafe Boulevard, 41st St. and Broadway, on Friday evening, Feb. 15, at 6:30 o'clock. The session on Friday morning will be devoted to "Circuit-Breaker Ratings." One paper will be presented, "Rating and Selection of Oil Circuit-Breakers," by E. M. Hewlett, J. M. Mahoney and G. A. Burnham. The session on "Meters and Measurements" will be held on Friday afternoon. Four papers are scheduled for this meeting: "A New Standard of Current and Potential," by C. T. Allcutt; "The Thermoelectric Standard Cell," by C. A. Hoxie; "The Character of the Thermal-Storage Demand Meter," by P. M. Lincoln; "Measurement of Power Losses in Dielectrics of Three-Conductor High-Tension Cables," by F. M. Farmer. Dr. A. C. Crehore will lecture at the Friday evening session on "Some Applications of Electromagnetic Theory to Matter." This lecture will be followed by a discussion. The session on "Alternating-Current Commutator Motors" will be held Saturday morning. Three papers will be presented: "Commutation in Alternating-Current Machinery," by Marius A. C. Latour; "The Secomor—a Kinematic Device Which Imitates the Performance of a Series-Wound Commutating Motor," by V. Karapetoff; and "The Polyphase Shunt Motor," by W. C. K. Altes.

Miscellaneous News

A Boiler Exploded at the plant of the Leesburg Silica Sand Co., near Mercer, Penn., Jan. 25, killing two and injuring two men. The cause of the explosion is unknown.

A Boiler Explosion in a shoe store at Peterboro, Ont., on Jan. 26 caused a fire that wiped out one-half of the business section of the town, entailing a loss of half a million dollars damage.

National Labor Policy Board Authorized—Acting on the recommendation of the Advisory Council (on labor problems), the Secretary of Labor will appoint a Policy Board, which will formulate a program for the settlement of difficulties between employers and employees arising during the war. It will be composed of twelve persons. The American Federation of Labor has been asked to nominate five persons to represent the workers and the National Industrial Conference Board five to represent the employers. Each group will nominate a representative of the public, thus completing the board.

New Power House Extension—The steel framing of the extension of the new power house of the Binghamton (N. Y.) Light, Heat and Power Co., is completed and the roof and side walls are well under way, being, on Jan. 19, about 50 per cent. finished. Work has been started on the installation of the additional boilers. The concrete work is in such condition that with a few warm days this end can be finished. During the enforced industrial shutdown it was possible to close this plant completely and to do a considerable amount of construction work to good advantage, with some saving in cost over what it would have been if the work had been done while the plant was running.

A Boiler Exploded on the Weirich farm, west of Washington, Penn., on Jan. 17 and damaged considerable property. Fortunately no one was injured. The cause of the explosion was a most unusual one. A contracting company was putting in a switch from the B. & O. railroad to the coal works, when one of the piles that was being driven for a trestle struck and broke a 5-in. oil line. The oil gushed out, ran down the hill to the boiler and caught fire, and in less than five minutes the boiler let go and was wrecked completely. Two tool sheds standing nearby were also burned. The property loss amounted to about $5000, as well as a financial loss occasioned by the holding up of the work awaiting new equipment.

Flywheel of Stoker Engine Burst — A series of circumstances led up to the injury of one man and the curtailment of the electric service in Cumberland (Md.) and the Georges Creek region early Monday morning, Jan. 21. It appears that some repair parts had been ordered and shipped by express from Boston on Jan. 8 for the governor of the stoker engine in the plant of the Edison Electric Illuminating Co. of Cumberland, but were not delivered as promptly as expected. In the meantime the engine was being operated and, although given unusual attention, it raced and burst the flywheel. Fragments of the wheel struck and broke the arm and hand of one of the employees. The service on several lines of electric railway was reduced one-half and all users of electric current were urged to minimize their demands so that all might have part service.

Drug Stores Recruiting Agents for Merchant Marine—Five hundred and twenty-six druggists scattered all over the New England States, from Fort Kent, Me., to Greenwich, Conn., and from Swanton, Vt., to Nantucket, have volunteered as recruiting agents for the new merchant marine, and will begin their official labors Feb. 4, according to a statement issued by Henry Howard, Director of Recruiting for the United States Shipping Board, Custom House, Boston, Mass. Each of the druggists will conduct an enrolling station at his store, at which young Americans from 17 to 27, inexperienced in seagoing, may put their names to applications for training as sailors firemen, oilers, water-tenders, cooks or stewards, on ships of a training squadron maintained by the Shipping Board, with headquarters at Boston, for preparing crews to serve on the new cargo fleets of the merchant marine. The coöperation of the druggists with the Shipping Board was brought about through the initiative of Louis K. Liggett, of Boston.

Government Control of Fuel Oil—On Feb. 4 President Wilson issued his proclamation putting under license manufacturers and distributors of fuel oil with an output of more than 100,000 barrels a year. The proclamation went into effect Feb. 11.

Preference in shipments is to be given first for war purposes at home and abroad, public utilities and private consumers in the order of necessity.

The classes referred to and the order of their preference are: (1) railroads and bunker fuel; (2) export deliveries or shipments for the United States army or navy; (3) export shipments for the navies and other war purposes of the Allies; (4) hospitals where oil is now being used as fuel; (5) public utilities and domestic consumers now using fuel oil (including gas oil); (6) shipyards engaged in Government work; (7) navy yards; (8) arsenals; (9) plants engaged in manufacture, production and storage of food products; (10) army and navy cantonments where oil is now being used as fuel; (11) industrial consumers engaged in the manufacture of munitions and other articles under Government orders; (12) all other classes.

Mark L. Requa, recently appointed Oil Director by Dr. Harry A. Garfield, Fuel Administrator, will have power to move oil to those industries needing it most, classes of priorities being issued by President Wilson in rules and regulations governing those distributors licensed. The proclamation is essentially a war distribution measure and exerts no control or restriction over the oil wells. Government officials say there is no shortage of fuel oil or gasoline production.

Traffic congestion preventing sufficient shipments to the Allies and allowing the movement of fuel oil to industries that are secondary in importance to war needs, caused the Government to issue the order.

Business Items

The January Issue of the "Walworth Log" is largely devoted to the newly opened Seattle branch of the Walworth Manufacturing Co. We recognize the work of L. F. Hamilton.

Walter A. Zelnicker Supply Co., of St. Louis, has established permanent offices at Minneapolis, Minn., at 627 Plymouth Building, to serve the North Central and Canadian trade. Richard K. Papin, formerly St. Louis and Southwestern representative of the Davenport Locomotive Works and for ten years manager of the Zelnicker Co.'s equipment department, is in charge. He is especially qualified to handle inquiries on rails, locomotives, cars, machinery, piling, tanks, etc., in his district.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Clearfields....	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets...	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.50—6.75
Buckwheat ..	4.30—5.00	2.75	5.50—6.00	6.00—6.25
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	4.00—4.25	3.25—3.75
Boiler	3.50—3.75	2.20	.....	.....

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago	One Year Ago
Buckwheat ..	$3.15–3.75	$2.50	$3.75	$3.40	$4.15
Rice	2.65–3.65	2.10	3.65	3.00	3.35
Boiler	2.45–2.85	1.95	3.55	3.15	....
Barley	2.15–2.40	1.85	2.40	2.05	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago	Feb. 7, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.35-2.75
2-in. lump..	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Steam egg ...	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2 in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Alexander—City plans to issue $10,000 bonds for the erection of an addition to its electric-lighting plant. J. A. Coley, Ch. Engr.

Ala., Mobile—The Mobile & Ohio Ry. plans to install electrical equipment in its grain elevator which is nearing completion. P. A. Wood, Ch. Engr.

Ark., Osceola—Town plans to install a 200 kva. generating unit in its electric-lighting plant. E. Teaford, Mgr.

Calif., Palo Alto—City voted $66,000 bonds to install a Diesel engine in its electric-lighting plant. J. F. Byxbee, Jr., City Engr. Noted Jan. 8.

Fla., Pensacola—The Pensacola Electric Co. plans to build a 13,200 volt transmission line from here to Pensacola Naval Station. T. J. Hanlon, Jr., Mgr.

Ga., Portland—The American Potash Co. is in the market for 200 kw. electrical equipment to operate fuller mills for manufacturing potash from sericite.

Kan., Leon—City having preliminary plans prepared by W. B. Rollins & Co., Engr., 209 Ry. Exch. Bldg., Kansas City, Mo., for the erection of an electric-lighting plant.

Ky., Walton—The Walton Electric Light Co. is in the market for an electric generator.

Mich., Marquette—City is having preliminary plans prepared for the erection of a power plant to include a 140 ft. pentstock. Estimated cost, $150,000. M. H. Wright, City Engr.

Miss., Canton—City plans to install new equipment in its electric-lighting plant including a surface condenser for a 200 hp. engine and spray equipment for cooling. J. T. Sharp, Jr., Mgr.

Miss., Houston—City plans to install new equipment in its electric-lighting plant including an 80 hp. crude oil engine directly connected to a 60 kw., 3 phase, 2300 volt, revolving field motor and switchboard, etc. A. G. Atkinson, Supt.

Mo., Wellsville—The Blattant Poultry and Manufacturing Co. plans to rebuild its electric-lighting plant which was recently destroyed by fire.

Neb., Falls City—City voted $75,000 bonds for the erection of an electric-lighting plant. K. J. C. Mullen, City Clerk. Noted Dec. 25.

Neb., Juniata—City plans an election soon to vote on a $7000 bond issue for the erection of a transmission line from here to Hastings.

N. J., Jersey City—The Board of Freeholders, Hudson County, is having plans prepared by P. A. Vivarttas, Arch., 110 4th St., West New York, for the erection of a 1 story, brick, power house and electric lighting plant. Noted Dec. 18.

N. Y., Albion—The State is in the market for two 150 hp. horizontal tubular boilers. Estimated cost, $10,000. L. F. Pilcher, Capitol, Albany, Arch.

Okla., Canadian—City plans to vote on bond issue for the erection of an electric-lighting plant.

Penn., Harrisburg—The Harrisburg Light and Power Co. plans to improve and enlarge its plant; also install 4 new stokers.

Penn., New Castle—The Mahoning & Shenango Ry. and Light Co. has been granted permission by the Public Service Commission to issue $2,000,000 bonds; the proceeds will be used to build additions and improvements to its system. E. H. Bell, Youngstown, Ohio, Mgr.

Va., Richmond—The Virginia Ry. and Power Co. plans to erect a 21 x 116 ft. concrete addition to its power house on 12th St. C. B. Buchanan, Gen. Mgr.

Wash., Seattle—The Board of Public Works will receive bids until March 1 for the erection of an addition to its hydro-electric power plant. Estimated cost, $5,000,000. J. D. Ross, Supt. of Light and Power.

Wash., Tacoma—City having plans prepared for the erection of an additional power plant with 17,000 hp. capacity. Estimated cost, $1,000,000. L. Evans, Gen. Supt.

Wis., Madison—The Di-Electric Manufacturing Co., incorporated with $40,000 capital stock, plans to build a plant. E. W. Smythe, Jr., Vroman Blk., and E. K. Frautschi, incorporators.

B. C., Nelson—The Swanetta Power Co., incorporated with $500,000 capital stock, plans to build a large hydro-electric plant on the Bend d'Oreille River, south of Nelson.

Ont., Elmira—A. S. Gingrich is in the market for a 30 to 35 hp. oil engine.

Ont., Hamilton—The Wentworth Orchard Co., Sun Life Bldg., is in the market for a 5 hp. electric motor for hydro power.

Ont., Merritton—The Riordon Pulp and Paper Co., Ltd., 355 Beaver Hall Sq., Montreal, will soon award the contract for the erection of a power plant.

Ont., Renfrew—The British Explosives, Ltd., is in the market for several 1/15 hp. and ½ hp. electric motors. W. C. Cram, Mgr.

Ont., Toronto—E. Pullen, 20 Main St., is in the market for a 10 hp. D. C., 550 volt, high speed motor.